Energy and Environmental Challenges to Security

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Energy and Environmental Challenges to Security

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INTRODUCTION

On 21 November 2007 the grand and elegant Delegates Hall of the Hungarian Parliament was the scene of the opening of a conference to discuss some of the most pressing issues of the day, those related to our unending thirst for energy, its environmental consequences, and the challenges that these bear on security. Over the next 3 days scientists, parliamentarians and their guests confronted, challenged, teased and cajoled each other in a NATO Advanced Research Workshop (ARW) entitled "Energy and Environmental Challenges to Security," affirming that knowledge and public service hold the keys to solving our greatest challenges. The magnitude of the security challenge was confirmed while this volume was being prepared. In mid-2008, the International Energy Agency issued a report concluding that US$45 trillion would be needed over the next half century to prevent energy shortages and greenhouse gas emissions from undermining global economic growth. But lest such large numbers cause us all to shrug, this volume brings attention to some of the more manageable aspects of the environment and energy security challenge – from addressing conflict resources such as illegal timber that contribute to corruption and regional instability, to means and mechanisms to enable the diversification of energy supplies, to environmental risk reduction strategies for particular installations.

The participants in the Hungarian Parliament building were atypical for a NATO Advanced Research Workshop. The meeting was held in conjunction with meetings of the Economics and Security, and Science and Technology Committees of the NATO Parliamentary Assembly, offering an opportunity for a group of highly accomplished scientists from member and partner countries to engage in dialogue with policymakers on these critical issues. This was a double-edged sword, however, since the injection of a dose of reality from those at the center of political processes resulted in piercing questions not usually asked by academics. This opportunity also presented the co-directors with a dilemma – how to manage the content so that it would ensure cross-fertilization and be the best basis for a dialogue of this kind. The solution was to provide high-level speakers on a range of topics in order to generate discussion on policy options, while presenting as background for the discussion a number of scientific papers related to the five session topics. The arrangement of the papers therefore does not follow precisely the workshop agenda, which can be found elsewhere in this volume together with a list of participants. The papers covered in this volume are divided into sections on post-conflict environmental challenges, transboundary environmental challenges, the international community's approach to environmental security challenges, transatlantic energy security, climate change, and environmental performance. The additional presentations and posters presented at the poster session can be found on the conference website at www.rec.org/natoworkshop.

This volume begins with three presentations that provide context and set the stage for the further papers. **Ben Slay** makes full use of his position as the 2007 Chair of the Environment and Security initiative to call for an end to "reckless unilateralism" and to urge those in positions of power to take urgent, *multilateral* action to address in particular the problem of climate change. Representing our partners from the NATO Parliamentary Assembly, **Mario Tagarinski and Andrius Avizius** lay out the major issues in the field of energy security, including an analysis of alternatives, while reminding us that for the Euro-Atlantic community, dependence on foreign energy sources is a long-term reality. The paper concludes with the observation that now more than ever solidarity is needed among Euro-Atlantic partners and NATO has a significant role to play in this. Our ARW was also unique in that the keynote address actually came at the end rather than the beginning of the conference, but we simply could not miss the opportunity to hear from **Norman Myers** on "Sources of Environmental Security Concerns." The *Time* Magazine hero of the environment pioneered the environmental security debate and never ceases to inspire with his manner of describing problems with utmost clarity. Among the startling statistics he raises, there are now more environmental refugees (25 million) in the world than political refuges and the number is doubling every 10 years. He estimates that to ensure environmental security, the world needs $124 billion per year for projects for clean water and sanitation, to counter desertification, increase energy efficiency, counter deforestation, etc. The sum of $124 billion is equivalent to 38 days of military spending worldwide. He calls for replacement of GDP as a growth indicator with a Genuine Progress Indicator (GPI). As he states, "We cannot launch fighter planes to resist global warming, we cannot despatch tanks to counter advancing deserts, we cannot fire the smartest missiles against rising sea levels."

In the next section, on Post-Conflict Environmental Challenges, **Chad Briggs** presents findings and options on the use of environmental health risk analysis in foreign policy. Using post-conflict scenarios in the Balkans he examines alternatives for taking vulnerabilities into account in formulating responses to security challenges. **Andjelka Mihajlov** follows with a discourse on the prospects and projected impact of a long-anticipated regional treaty for South Eastern Europe on cooperation in the energy field**. Lisa Tilney** presents a case study related to the misuse of timber resources in Bosnia-Herzegovina – its greatest export earner – to prop up corrupt regimes. There, the absence of the rule of law has led to particular forms of environmental degradation that threaten neighboring states both due to the environmental impacts and to the security implications. An in-depth analysis of energy and environmental challenges in one particular land that is at the center of security tensions – Kosovo – is provided by **Nezakete Hakaj**. The workshop also benefited from Andrew Morton's presentation of field observations gained through UNEP's key role in post-conflict assessments that are applied in areas of resolved but also of frozen conflict, with particular attention on the Darfur region of Sudan.

The section on Transboundary Environmental Challenges begins with **Anton Khlopkov's** contribution outlining strategies and initiatives to account for and hold materials for nuclear enrichment, including the most advanced projects for international nuclear fuel cycle centers. He concludes that a current Russian initiative for a pilot international uranium enrichment center offers great hopes for reducing risks associated with spent nuclear fuel. The specific security-environment nexus along the border between Austria and Czech Republic is examined in depth by **Nikola and Alois Hynek**. They apply cultural/landscape and social perspectives in a manner informed by environmental security to their findings on cross-border perceptions of environmental problems. The role of international law in transnational water use as an element of environmental security is covered in the next contribution by **Dragoljub Todic and Vid Vukasovic**, who view in particular the circumstances of Serbia as a country lagging behind its neighbors in adopting international standards. At the ARW this session also included a stimulating discussion on the infamous nuclear waste problems of the Arctic nuclear fleet with a contribution from Nils Bohmer of the Bellona Foundation, and a discussion of recent and ongoing experiences on subregional implementation of global and regional agreements applying an ecosystem approach in the Sava River basin and in the Adriatic Sea led by Mitja Bricelj of Slovenia.

The focus of the ARW session on the International Community's Approach to Environmental Security Challenges was on the Environment and Security Initiative, or ENVSEC. Representatives of this innovative, six-party partnership presented both their respective organization's approach to the issue of environment and security, as well as the key elements and benefits of cooperation. ENVSEC includes partners whose mandate is essentially environmental (UNEP, REC), developmental or economic (UNDP, UNECE), military (NATO), regional (REC, OSCE, UNECE), and security-related (OSCE). This initiative has already been the topic of study, and an interesting and insightful critique is provided by **Fiona Borthwick**. The workshop itself included a panel of representatives from the ENVSEC partners, including Marta Szigeti Bonifert of REC, James McQuaid and Arpad Vincze of NATO, and Bernard Snoy of OSCE. The contribution of **McQuaid and**

Vincze on NATO's approach to energy and environmental security through its Science for Peace and Security Programme is included in this volume.

While energy and environment are closely related, the next two sections deal more with the energy side of the equation. The topic of Transatlantic Energy Security is introduced through a dire picture of the consequences flowing from dependence on Middle Eastern sources of oil presented by **Gal Luft** through his analysis of the international behavior of oil-rich states. The national approach of Bulgaria to energetics management and environmental quality in a transatlantic energy security context is analyzed in great detail by **Plamen Gramatikov,** who provides interesting insights with respect to this strategically placed country. Middle East security concerns are discussed with a regional perspective by **Khaled Marafi,** who, while reaching some of the same conclusions reached by Luft, proposes NATO "out of area" operations as a possible measure to contribute to energy security. **Dan Milstein and Aleh Cherp** point out that ending international subsidies can also be a security issue. While claims that Ukraine has a right to gas subsidized by the Russian economy indefinitely are dubious, issues of security of supply and the maintenance of subsidies for political purposes elsewhere raise serious questions about the methods Russia uses for subsidy elimination. **Sergey Boruk and Igor Winkler** examine the potential for alternative sources of carbon-based fuels through coal waste reprocessing to address environmental and security concerns. Finally, **Ibrahim Krasniqi** takes aim at one of the key energy and environmental security issues in Europe – the vast energy potential of Kosovo's lignite resources – through a discussion of the possible application of clean technologies in lignite power plants. In Budapest this session was kicked off with a provocative examination of the geopolitical aspects of European dependence on Russia as a source or transit point of natural gas by Ambassador Istvan Gyarmati of Hungary. Now Director of the International Centre for Democratic Transition (ICDT), his remarks which seem prescient based on recent events, noted that Russia is effectively pursuing the old-fashioned policy of *Realpolitik*, creating tension with increasingly post-modern actors such as the European Union. He urged European nations to come to terms with the new reality by adopting a united approach towards Russia, and to develop a common energy policy. Edit Herczog, member of the European Parliament, presented views on European policy-makers' opportunities to address future energy challenges.

The penultimate section deals with one of the biggest challenges of energy and environmental security facing the world today – climate change. This part of the volume begins with an in-depth assessment by **Ralph Sims** of the International Energy Agency of long-term energy supply and demand and the realistic contributions of various sources to our energy future. Starkly opposing views on how to make progress in reducing greenhouse gas emissions globally were presented by the two keynote speakers, Elliot Morley, MP, the UK Government's special representative on climate change, and U.S. Ambassador April Foley, including each speaker's view on what could be expected in a "post-Kyoto world." **Ambassador Foley's** remarks are included in this volume. A major point of contention was whether a mandatory approach based on international obligations or a voluntary, business-led approach was the right one. The discussion included a debate on the realistic prospects for transition to a post-carbon economy and the relative flexibility of particular economies to meet this challenge. The fact that certain economies were "fixed" in orientation towards a carbon economy led to the conclusion that transition would be especially painful for them. Nor could those who financially benefited from a carbon economy, such as oil-exporting countries, be expected to contribute their riches to a mechanism for their own impoverishment. It was also pointed out that in several decades the argument that those countries which "profited" from greenhouse gas emissions should pay for reductions would be applied to today's emerging economies such as China and India. The potential for disruption and devastation arising from climate change is illustrated by the contribution of **Andras Vag** on forced migration scenarios. The links between climate change and other environmental changes, migration of peoples, and challenges to security are increasingly on the international agenda. Alternative energy sources play a role in any debate about climate change and future sources of energy. **Ermira Fida et al.** provide an in-depth analysis of the potential effects of climate change scenarios on Albania's extensive hydropower resources. Albania currently has one of the highest rates of hydropower usage in Europe, a situation that is endangered due to increasing demand and the threats of global warming. While each solution may have an overall small effect, incrementally they may be significant. Small hydropower resources in border areas of Ukraine offer the potential to contribute to its energy security in the future, as posited by **Igor Winkler**. Finally, **Bela Rabi** examines often-overlooked risks associated with the use of renewables.

A number of papers presented at the workshop dealt with specific issues related to environmental performance that could have an impact on environmental security, in particular in the area of risk reduction. These papers were connected with various workshop sessions, but have been gathered together in this volume in a new section. **Lyudmyla Zahvoyska** presents stochastic simulation methodologies that could be applied in increasing energy efficiency through better environmental performance of technological systems. Problems of environmental contamination and improved management of the Elbasan region of Albania are the subject of a contribution by **Fatbardh Sallaku et al**. Environmental risks associated with important economic sectors may present security risks as well. **Meral Mungan and Yetis Ulku** complete this volume with a detailed environmental risk assessment of a textile factory in Turkey.

It is impossible to capture in a collection of conference papers the dynamism of the conversation or the ideas that came out during the workshop (one example is the provocative notion that the proceeds of fossil fuel exploitation should be applied to solving the problems of the post-carbon economy, meaning that petroleum-exporting countries should foot a large part of the bill). These are in fact equal in importance to the papers themselves, since both the scholars and the parliamentarians took something away to apply in their own spheres of work. Those interested in the conceptual nuggets of the conference may find them by listening to the recorded sessions. Putting this volume together has helped us to understand the limits editors face in bringing a cohesive voice to such a wide range of viewpoints as may be expressed in a conference on key issues. We ourselves have sometimes been critical of other such publications as trying to cover too much and too little at the same time. We now apologize to those we have reviewed.

As pointed out in the contribution to this volume by McQuaid and Vincze, the attention given to energy and environmental challenges to security through our ARW represents a continuation and expansion of NATO's efforts to deal with an increasingly recognized set of security issues, through its Science for Peace and Security Programme. The importance NATO places on environmental security was also demonstrated when it joined UNEP, UNDP and OSCE in the Environment and Security initiative as an associate member (membership has since expanded to include REC and UNECE).

It is at last time to thank a number of people without whom this volume would not have been made. Suzanne Michaelis gave us the opportunity and encouragement to hold the ARW in the first place. Paul Cook and later Andrius Avizius championed the idea of a joint meeting within the NATO PA. Our brave lieutenants Rachel Hideg and Reena Panchal followed through and took care of nearly everything. Diana Culo took over from Rachel and shepherded the publication to completion. Mihallaq Qirjo brought the co-directors together. Marta Szigeti Bonifert gave the support of the REC and encouraged us to take this on. Jim McQuaid and Deniz Beten helped others within NATO to understand the special nature of the ARW and the opportunities that it afforded. The excellent setting of the Hungarian Parliament stimulated us to do more, and for that we thank Karoly Tuzes and Karina Brandenburg. Gabor Palinkas was an excellent partner on behalf of ICDT. Katalin Szili, John Sewel, Michael Mates, Attila Mesterhazy, Istvan Gyarmati, Bernard Snoy, Ben Slay and Edit Herczog lent their substantial weight to the proceedings. The generous sponsorship of related events by the Ministry of Defence and by Magyar Villamos Müvek Zrt. provided us relaxing and diverting moments. Zsolt Bauer handled communications with

Hungarian partners. As co-directors, we are also glad that the ARW gave us an opportunity to form a collaboration that is continuing.

Finally, we wish to mention those other colleagues not mentioned above from the partner organizations within the Environment and Security initiative whose dedication has helped to motivate us, including Marc Baltes, Jelena Beronja, Jasmina Bogdanovic, Christophe Bouvier, Raul Daussa, Nickolai Denisov, Chris De Wispelaere, Harald Egerer, Tsvetelina Filipova, Inkar Kadyrzhanova, Bo Libert, Miriam Markus-Johansson, Cecile Monnier, Saba Nordstrom, Marika Palosaari, Andrey Pogrebnyak, Oleksandra Ratushnyak, Ajiniyaz Reimov, Dana Carmen Romanescu, Otto Simonett, Milada Sladkova, Isabelle Sorg, Peter Svedberg, David Swalley, Jaco Tavernier, Saija Vuola and of course, Frits Schlingemann.

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Ermira Fida represents Albania under the United Nations Framework Convention on Climate Change (UNFCCC) and serves as Vice-Chair of the Subsidiary Body for Scientific and Technological Advice (SBSTA) and as a member of the Adaptation Fund. She has more than 14 years of experience working with climate change issues in Albania including for the last 10 years as manager of the UNDP funded Umbrella Program on Climate Change for Albania. She has degrees in Special Physics and a Masters of Business Administration, and is author or co-author of many publications on energy and climate change issued by international organizations such as UNDP, UNFCCC, and REC.

Ambassador April H. Foley has had an extensive career in professional management. Most recently, she served as First Vice President and Vice Chairman of the Export–Import Bank of the U.S. Prior to that, she served as a member of the Board of Directors of Ex-Im Bank. She worked for 17 years as an executive for PepsiCo in roles including strategic planning, financial management, and mergers and acquisitions. She also worked for Pfizer and The Reader's Digest. In addition to her business experience, she has held significant volunteer leadership positions. She holds a Bachelor of Arts Degree from Smith College and an MBA from Harvard University. Ambassador Foley was sworn in by Secretary of State, Condoleezza Rice on July 5, 2006. She arrived in Hungary on August 10, 2006, and presented her credentials to President of the Republic of Hungary Laszlo Solyom on August 18, 2006.

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ENERGY SECURITY FOR THE EURO-ATLANTIC REGION*

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Abstract: Energy security has become one of the central themes for the international community and organisations such as NATO, because the importance of energy has never been as overwhelming as it is today. The dependency of many NATO countries on foreign energy supplies is going to increase. The article discusses possible alternatives, including diversification of supply of hydrocarbons, exploitation of unconventional hydrocarbon resources, nuclear energy, renewables and increased energy efficiency.

The bulk of the problems associated with energy security derive from the fact that instead of being treated just like any other sector of the economy, energy is often subject to an extensive state control. If left to the market forces and competition alone, it is very likely that many acute issues would disappear altogether. Therefore, while trying to promote the notion of liberalising the energy market, the Euro-Atlantic community has no other choice but to continue playing old geopolitical games. In the short term, it needs to augment its solidarity to ensure that none of its members are exposed to energy blackmailing. NATO should play an increasing role in the domain of energy security. The Alliance can provide an added value both due to its capacity in the area of physical protection of energy infrastructure and

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because it is a unique vehicle for co-operation and co-ordination among members of the transatlantic community.

Keywords: Caspian Sea resources, diversification, energy consumption, energy efficiency, energy security, geopolitics, LNG, NATO, nuclear renaissance, pipelines, renewables, Russia's oil and gas, unconventional sources

1. Introduction

It should not come as a surprise that energy security has become one of the most central themes for the international community and organisations such as NATO, which was created primarily to deal with hard security challenges. Energy has always been a factor in international relations, sometimes even causing military conflicts. However, the importance of energy has never been as overwhelming as it is today, and it will undoubtedly increase in coming decades. We are already consuming twice as much energy resources as 30 years ago and this trend is projected to accelerate. In the mid-19th century, an average human being consumed an amount of energy equivalent to 150 watts per hour (W/h). In the 21st century, this figure has increased more than 13-fold to about 2,000 W/h.[1] Our societies are more than ever 'addicted' to energy and any major disruption of supply would cause much more damage to our economies and our way of life than it would have done in the not too distant past. Such a tremendous growth in energy consumption also results in a dependence on foreign energy supplies, not to mention the increase in pressure on the environment.

Energy security is defined as "assurance of the ability to access the energy resources required for the continued development of national power."[2] However, energy security has different meanings around the world. While the United States and the Eastern and Central European nations are preoccupied with the security of energy supply at a reasonable price, China is seeking to secure the supply for its booming economy almost regardless of the cost, the EU is striving for more efficient management of the demand and Russia is associating this with access to foreign markets. Private industry calls for a fair

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[1] Speech by Professor Dennis Snower, President, The Kiel Institute for the World Economy, XVI Malente Symposium "Energy, Climate, and Future Welfare – Changing Global Dynamics", Lubeck. 8–10 October 2006.

[2] Energy and Security: Toward a New Foreign Policy Strategy. Jan H. Kalicki and David L. Goldwyn (eds.). The Johns Hopkins University Press, Baltimore, MD. 2005. P. 9.

and transparent global energy market. Environmental groups and pro-green governments believe energy security is the flip side of environmental interests. Some may perceive energy security as the physical safety of energy infrastructure. And yet others almost wish their country had no oil and gas resources, because often revenues from these resources merely strengthen ruling authoritarian regimes, diminish prospects for democratisation and provide no tangible benefits for society.

What does it take to be secure in terms of energy? It is generally agreed that the supply of energy resources has to be diversified, including a wider range of available energy sources as well as different options for transportation of energy commodities. Stability and transparency of the global oil and gas market is another important precondition. Producers also need to have a 'spare capacity' to increase production above normal levels in the event of a crisis, while consumers need to maintain emergency stocks, such as the US Strategic Petroleum Reserve of 700 million barrels of oil. Energy security cannot be attained without proper attention to the physical protection of energy assets as well as adequate funding of research and development (R&D) in the field of energy.

Looking from today's standpoint and bearing in mind the challenge of climate change, it would be difficult to imagine a sustainable future other than a non-carbon future. However, it is also obvious that hydrocarbons will continue to play a significant role for decades to come. Reducing poverty is the top concern for many millions living in the developing world and a carbon-based industry remains the cheapest way to develop the economy. Some 75% of China's electricity is generated from coal and this country builds approximately one coal-based plant every week.

A non-carbon future will eventually happen not because sooner or later mankind will deplete all existing resources of oil, gas and coal. As Sheikh Yamani, the former Oil Minister of Saudi Arabia once put it, "the Stone Age did not come to an end because of a lack of stones." The two key drivers towards new energy approaches are increasing environmental awareness and a striving for energy security.

2. Energy Demand and Supply: The Trends

The distribution of energy demand and supply across the world is highly uneven. More than 60% of the world's proven oil reserves are found in the Middle East. Most of the world's natural gas is concentrated in just three countries: Russia (27%), Iran (15%) and Qatar (14%). Conversely the developed world (members of the OECD) accounts for only 7–8% of global oil and gas reserves while consuming 50% of the world's natural gas and 60% of its oil.

Moreover, Middle Eastern resources are in a much more favourable position in terms of exploration and development costs.[3]

2.1. DEMAND

According to estimates by the International Energy Agency (IEA), the world's primary energy needs are expected to grow by 55% between 2005 and 2030. The acceleration of the growth in demand stems largely from the developing world: 74% of the global increase. China and India's booming economies alone will contribute to almost half of the overall increase in energy consumption over that period. In aggregate, the developing world will account for more than half of the world's primary energy consumption by 2030, compared with 41% today. China, having already surpassed the United States as the world's largest CO_2 emitter, is projected to become the world's largest consumer of energy by 2010.

Fossil fuels will continue to dominate: their share in the global energy mix was 81% in 2005 and is expected to reach 82% in 2030. Non-fossil energy sources constitute the remaining 18–19%: in 2005, nuclear energy accounted for 6% (expected to drop to 5% in 2030), biomass and waste 10% (9% in 2030) and hydropower 2% (IEA data).

With regard to specific types of fossil fuel, the picture is the following[4]:

- In 2006, the share of oil was 35% – 84 million barrels per day (mb/day). By 2030, this will decrease relatively to 32%, but in absolute terms, the demand will grow to 116 mb/day.
- Coal is the second most popular fossil fuel and its demand is projected to increase dramatically, reaching 28% of the world's energy consumption by 2030, compared with 25% today. In absolute terms, global coal demand will soar from 4,154 million tonnes of coal equivalent (Mtce) in 2005 to 7,173 Mtce in 2030. The developing world is the major coal consumer (with China and India alone accounting for almost half the world's consumption) and its share is expected to increase further.
- Natural gas demand is expected to grow more consistently, from 21% of total energy demand today to 22% in 2030. In absolute terms, however, the global consumption of gas will increase by two thirds: 4,800 bcm in 2030, compared with approximately 3,000 today.

Oil, coal and gas are different and can seldom substitute one another. Oil is predominantly (approximately 70%) used to produce fuel for transportation,

[3] Energy Security and Climate Policy: Assessing Interactions. OECD/IEA 2007. P. 36.
[4] World Energy Outlook 2007. China and India Insights. International Energy Agency.

while natural gas and coal are, above all, sources of heating and electricity generation. In this context, it is predicted that global electricity consumption will almost double during the period 2005–2030 and the amount of vehicles on the roads is expected to reach 2 billion by 2050, compared with 700 million today.

The soaring demand and particularly the growth of China and India is undoubtedly the key factor causing oil prices to rocket sky-high over the past few years (it has to be noted, however, that in real terms, the price of oil has still not reached its all-time high of the late 1970s). Chinese and Indian companies often do not have a profit motive and are mainly preoccupied by a secured flow of oil, even if they have to overpay or make political concessions, which distort competition in the market. Natural gas is traditionally treated as oil's 'younger brother' and its price has also risen accordingly. Coal will remain an attractive source of energy for a number of countries, particularly China, which has vast coal resources. The cost factor features prominently in Chinese economic calculations: in the coal sector, US$1 produces approximately 1 million British Thermal Units (BTU), while the same amount of energy coming from imported natural gas would cost about $7.[5] China is already becoming a net importer of coal.

2.1.1. Europe

With few exceptions, European countries are very dependent on foreign energy supplies. Overall, Europe imports half of its primary energy sources and this figure will increase to more than two thirds by 2030.[6] Germany, for instance, imports 100% of its uranium for its nuclear power sector, 97% of oil, 83% of gas and 61% of coal. Germany is self-sufficient only in lignite (which is an extremely dirty fuel) and renewable fuels, but these only account for 8% of the country's energy consumption.[7] Russia and the Middle East are the key suppliers, in terms of gas and oil, respectively: it is estimated that by 2030 EU countries will import 40% of their gas from Russia and 45% of their oil from the Middle East.[8] Countries such as Finland, Slovakia, the three

[5] Energy, Climate and Security Concerns of the Future. A speech by Professor John M. Deutch, Massachusetts Institute of Technology. XVI Malente Symposium "Energy, Climate, and Future Welfare – Changing Global Dynamics", Lubeck. 8–10 October 2006.
[6] NATO and Energy Security. CRS Report for Congress. By Paul Galis. December 2007.
[7] Speech by Prof. Dieter Feddersen, Member of the Board, Dräger Foundation, XVI Malente Symposium "Energy, Climate, and Future Welfare – Changing Global Dynamics", Lubeck. 8–10 October 2006.
[8] NATO and Energy Security. CRS Report for Congress. By Paul Galis. December 2007.

Baltic States, Georgia and Belarus have no alternative but to use Russia's gas, and the Czech Republic, Hungary, Bulgaria, Greece, Austria and Turkey are also extremely dependent on Russian gas supplies.[9]

When it comes to oil, European Union nations will be consuming virtually the same quantity of oil over the next quarter of a century – less than 14 mb/day. OECD-Europe consumes more oil than it produces by approximately 9 mb/day and the dependence on oil imports is increasing (IEA data).

The situation is even more complicated with natural gas: its consumption in Europe is projected to increase from 22.8% of the market in 2000 to 32% in 2030, largely because of a considerable increase in electric power generation (IEA data). Currently, the EU domestically produces 37% of its gas needs, 29% come from Russia, 17% from Norway and 13% from Algeria.[10] The domestic production of gas within the EU, on the other hand, is projected to decrease from 216 bcm in 2000 to 129 bcm in 2030. Hence, the reliance on imported gas will increase considerably, possibly up to 80% of the total gas consumption by 2030.[11] Today, less than half the gas consumed has to be imported.

Consumption of coal in the EU is steadily declining (453 Mtce in 2005 and projected to be 393 Mtce in 2030) and domestic coal output is dropping even more sharply, largely thanks to the elimination of remaining subsidies and the concerted EU policy to fight climate change. Currently, the EU has to import almost half of its coal demand and this dependence will increase with time (IEA data).

2.1.2. North America

In contrast to Europe, the United States is much less concerned about the flow of natural gas and a secured supply for its electricity generation industry. Essentially for the United States, energy security is associated with the security of oil supply for its transportation sector, 97% of which is petroleum dependent.[12] According to IEA estimates, North America's oil demand is expected to increase from 25 mb/day in 2006 to 30 mb/day in 2030 (IEA

[9] US Energy Information Administration data.

[10] The Russian Dimension and Europe's External Energy Policy. By Dieter Helm. University of Oxford, Oxford. September 2007. http://www.dieterhelm.co.uk/publications/Russian_dimension.pdf

[11] Reforming the Gas Market. By Loyola de Palacio. Energy and Security: Toward a New Foreign Policy Strategy. Jan H. Kalicki and David L. Goldwyn (eds.). The Johns Hopkins University Press, Baltimore, MD. 2005. Pp. 176–177.

[12] Dependence on Middle East energy and its impact on global security. By Gal Luft, Executive Director, Institute for the Analysis of Global Security. http://www.iags.org/luft_dependence_on_middle_east_energy.pdf

data). North America is an oil net importer by approximately 12 mb/day and its dependence on oil imports is expected to increase. Specifically, the United States imports approximately 60% of its oil needs, up from about 30% during the times of the 1973 oil crisis. Two thirds of oil imports come from other American countries (Mexico, Canada and Venezuela), one sixth (10% of all US oil consumption) comes from the Middle East and the remaining one sixth is divided between the North Sea and West Africa.[13] Currently, Russia's oil exports to the US are negligible, but they could increase with the completion of the Murmansk pipeline, reaching the level of 10–13% of all US oil imports by 2010.[14]

Regarding gas, currently North America is practically self-sufficient. However, by 2030, consumption of natural gas is expected to increase from 765 bcm to almost 1,000 bcm and this region is expected to become a major gas importer – 16% of the region's gas consumption (IEA data). When it comes to coal, North America is essentially producing as much as it is consuming and this equilibrium is likely to remain in the foreseeable future. Both coal demand and production are projected to increase slightly over the coming decades.

2.2. SUPPLY

In view of the unprecedented rise in demand, it is legitimate to ask if primary energy suppliers will be capable of meeting the needs. In 1956, geologist King Hubert, the father of the peak oil theory, forecasted that the availability of oil would drop and prices would rise dramatically between 1965 and 1970. He may have been right concerning the price, but his predictions concerning the amount and availability of this resource have not stood the test of time. Never before have discovered oil reserves been greater than at present.

The world is far from depleting its fossil fuel resources. Looking at today's situation, the limits of 40 years for oil and 70 years for natural gas seem to be realistic. However, these frequently quoted figures do not take into account unconfirmed oil and gas reserves or those that cannot be accessed with today's technology. Experts claim that in the period between 1860 and 1998, the world consumed approximately 300 Gt of fossil fuel. However, the known resources are some 1,000 Gt, and an additional 6,000 Gt could potentially

[13] Energy Security and markets. By Daniel Yergin. Energy and Security: Toward a New Foreign Policy Strategy. Jan H. Kalicki and David L. Goldwyn (eds.). The Johns Hopkins University Press, Baltimore, MD. 2005. P. 53.

[14] Russia and the Caspian Sea Region. By Julia Nanay. Energy and Security: Toward a New Foreign Policy Strategy. Jan H. Kalicki and David L. Goldwyn (eds.). The Johns Hopkins University Press, Baltimore, MD. 2005. P. 137.

be confirmed in future. In addition, future technologies can be expected to find a cost-effective solution to extract unconventional oil resources, such as tar pits in Canada. Adding unconventional hydrocarbons such as methane hydrates could push the world's fossil fuel reserves up to 17,000 Gt. With annual consumption of 6.5 Gt today, one can conclude that the threat of the world running out of fossil fuels is rather exaggerated.[15]

Thus, our economies can be expected to remain oil-, gas- and coal-driven in the foreseeable future. Even if renewable or other non-carbon energy becomes predominant in the future, the use of fossil fuels may still remain significant or even be greater in absolute terms as the overall energy consumption grows progressively.

However, the abundance of hydrocarbons alone is not enough to satisfy the growing demand: experts are seriously worried that investment in oil and gas infrastructure is currently far from adequate. Underinvestment – and not the lack of oil – seems to be the main factor causing fears over the security of oil supply. The remarkable growth in global primary energy demand raises serious doubts as to whether this growth is sustainable and if the suppliers will have the capacity to match it. IEA projects that, under current trends, during the period between 2006 and 2015, the world's oil industry will need to add 37.5 mb/day of gross capacity (almost half of the current global oil production) to satisfy the growing demand and to compensate for the depletion of existing oil fields. OPEC and non-OPEC oil producers have announced plans to add 25 mb/day by 2015. Thus, a further 12.5 mb/day of gross capacity would be needed.[16] However, it is very likely that even these predictions are too optimistic as decline rates of existing fields could be much higher than in the past.

All in all, in order to meet the rising demand in oil and gas, approximately US$22 trillion of investment in energy infrastructure will be needed between 2005 and 2030. Half of this amount would go to enhance power generation capacity as well as transmission and distribution networks. Most of the remaining half would be used to develop additional oil and gas fields, while investments in the coal industry are projected to be relatively small. More than half of all investments in energy infrastructure will have to be met by the developing world – China alone will need to invest almost US$4 trillion (IEA data).

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[15] Speech by Prof. Gernot Klepper, Director, The Kiel Institute for the World Economy, XVI Malente Symposium "Energy, Climate, and Future Welfare – Changing Global Dynamics", Lubeck. 8–10 October 2006.

[16] Presentation by Mr. Aad van Bohemen, International Energy Agency. Seminar on Security of Energy Supplies – The Role of NATO and Other International Organisations, Brussels. 17 January 2008.

The underinvestment is to a large extent the outcome of low oil prices in the early 1990s, which resulted in production capacity constraints. Also, in many countries, the oil and gas sectors have always been subject to absolute governmental control with foreign investments either strictly limited or entirely forbidden. More than half of the world's oil and gas companies have no foreign participation or investment.[17]

2.2.1. Domestic Production in the Euro-Atlantic Region

A few decades ago, the United States was the world's largest single producer of oil, but its output has been steadily declining since the mid-1980s. It is projected that US oil production will continue to fall at the rate of about 2% a year over the period of 2000–2030. During the same period, OECD Europe (the North Sea) oil production might decline even more substantially – at a rate of about 3%.[18] During the next quarter of a century, North America will be producing slightly more oil than it does now: 15.2 mb/day in 2030 compared with 13.9 in 2006. However, this increase will only be caused by a more active exploitation of Canadian oil reserves, as the US domestic production is projected to fall from 7.1 to 6.3 mb/day. The decline in the OECD-Europe production will probably be even more dramatic: from 5.2 mb/day to just 2.5 mb/day (IEA data).

With regard to natural gas, North American production will grow slowly over the next few decades, while OECD-Europe (North Sea) resources are likely to decline from 315 bcm in 2005 to 251 bcm in 2030.[19]

The only realistic possibility to increase the output of fossil fuels in the Euro-Atlantic region is by exploiting new resources in the Arctic region. While the scientific community and environmentalists grow increasingly concerned about global warming, policy-makers and businessmen are already looking into ways to benefit from the Arctic thaw. It is a politically stable area and it is much closer to Europe than the Gulf region. There are a number of related challenges, however, such as remote location, cold weather, limited logistics and infrastructure, presence of sea ice, reduced daylight, etc.

The ice floe equivalent of the landmass of Texas and Arizona has melted within the last 30 years. A number of specialists in the field forecast that the

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[17] Presentation by Mrs. Lucia van Geuns, Clingendael International Energy Programme. Seminar on Security of Energy Supplies – The Role of NATO and Other International Organisations, Brussels. 17 January 2008.

[18] World Energy Futures. By Adam E. Sieminski. Energy and Security: Toward a New Foreign Policy Strategy. Jan H. Kalicki and David L. Goldwyn (eds.). The Johns Hopkins University Press, Baltimore, MD. 2005. P. 32.

[19] World Energy Outlook 2007. China and India Insights. International Energy Agency.

Arctic Ocean could be ice-free by the summer of 2040, thus opening new navigable ways in the North and facilitating the extraction of the Arctic resources. For the first time in recorded history, in the summer of 2007 the Northwest Passage was ice-free all the way from the Pacific to the Atlantic. In the long term the disappearance of the ice fields may allow the mineral resources to be mined. It is believed that a vast and rich reserve lurks in the deep, including oil, diamonds, gold, silver, lead, copper and zinc (Kopp, Dominique, September 2007). That represents a real El Dorado for northern states such as Russia, Canada, the United States, Denmark, Norway, Sweden, Finland and Iceland. But are the Arctic resources the answer? Specialists are divided on this question.

A regularly-quoted US Geological Survey (USGS) report from 2000 states that the Arctic contains 25% of the world's undiscovered oil and gas reserves (Graff, James, October 2007). Against the backdrop of the energy-supply crisis that is currently affecting the oil sector, these promising prospects have generated high expectations among governments and provoked a rush towards the North. The accuracy of the data of the USGS report, however, has been questioned by a growing number of specialists and the figure of 14% seems to be more realistic.[20]

The exploitation of the Arctic resources has already begun, encouraging joint co-operation projects, such as Gazprom and Norsk/Hydro's project to develop a very rich Shtokman field in the Barents Sea. Adopting new technology has allowed Statoil to develop the first offshore complex in the Barents Sea – the Snøhvit project. Without surface installations, this project involves bringing huge volumes of natural gas to land for liquefaction and export. The liquefaction plant is the first of its kind in Europe and the world's northernmost. One of the major challenges is to increase pressure in gas reservoirs in order to push gas towards production wells. To obtain this result, Statoil uses a practice to inject cold seawater into reservoirs.

2.2.2. OPEC

Ever since it was established, the OPEC cartel has become an extremely important global economic and even geopolitical actor. While Russian, Caspian or Arctic oil resources can significantly contribute to the European

[20] It appears that the USGS report included in its calculation seven oil and gas basins located on areas of land laying outside the Artic region. Once the East Siberian basin is excluded from the calculation, the 25% estimate of the USGS drops to 14%. See Bailey, Alan. October 2007.

and North American energy mix, they will never be able to fully replace vast Middle Eastern resources. According to the IEA's World Energy Outlook 2007, OPEC's share of conventional and non-conventional oil production will grow from 42% today (36 mb/day) to 52% in 2030 (61 mb/day), provided that OPEC countries make the necessary investments in their oil industry. Middle East countries are responsible for more than two thirds of OPEC oil production. Saudi Arabia alone is producing about 10.5 mb/day, almost as much as the United States and OECD-Europe combined.[21]

Thanks to OPEC rules, its member countries are obliged to honour certain caps on their oil production. Because of that, OPEC oil industries are either not operating at full capacity or storing the excess oil. In any case, these countries have a 'spare capacity', which can be used in the event of a crisis. Non-OPEC oil companies, on the other hand, do not have incentives to create 'spare capacity'.[22] However, by attempting to accommodate the dramatic rise in global demand, OPEC's liquidity mechanism has eroded from 10% of the market in 2002 to about 3% today. Because of that, as Gal Luft has put it elsewhere in this volume, "the oil market today resembles a car without shock absorbers: the tiniest bump on the road can send a passenger to the ceiling."[23]

In terms of natural gas, the role of the Middle East is expected to grow dramatically with production trebling between 2005 and 2030. By the end of that period the Middle East will produce 940 bcm of gas, more than Russia, which today is producing two times more gas than the Middle East region (IEA data).

It has been suggested that an organisation of gas exporting countries (OGEC) could also be established, following the model of OPEC. In 2001, 15 of the world's major gas producers, including Russia, Algeria and Qatar, founded the Gas Exporting Countries Forum (GECF). GECF countries control 73% of global gas reserves and 42% of global gas output. There are some speculations that GECF could evolve into an equivalent of OPEC in terms of natural gas, but a number of factors make it less likely, including the regionalisation of gas markets, the growing number of suppliers, the dominance of long-term contracts and the uncertainty over gas pricing.[24]

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[21] World Energy Outlook 2007. China and India Insights. International Energy Agency.

[22] Russia and the Caspian Sea Region. By Julia Nanay. Energy and Security: Toward a New Foreign Policy Strategy. Jan H. Kalicki and David L. Goldwyn (eds.). The Johns Hopkins University Press, Baltimore, MD. 2005. P. 130.

[23] Dependence on Middle East energy and its impact on global security. By Gal Luft, in this volume.

[24] World Energy Outlook 2007. China and India Insights. International Energy Agency.

2.2.3. *Russia*

Russia is probably the most important single energy supplier for the Euro-Atlantic region. Since it is also one of the world's most ambitious political and military actors, relations between Russia and its trade partners in the field of energy tend to be heavily politicised. Russia's political establishment almost unanimously considers the country's energy resources to be a key vehicle for Russia's economic modernisation and restoration of its international prestige.

Russia's oil sector is projected to continue its moderate growth from 9.7 mb/day in 2006 to 11.2 mb/day in 2030. Russia's domestic consumption of oil over the same period is expected to increase from 2.6 to 3.3 mb/day. As far as natural gas is concerned, Russia is a major global power. It currently produces more than 20% of the global output and production is projected to increase further from 639 bcm in 2005 to 823 bcm in 2030 (IEA data). Russia supplies a quarter of Europe's natural gas requirements and will probably increase its share to around 40% by 2020.[25]

The prospects of growth in Russia's oil and gas industry are subject to debate. Firstly, Russia needs significant investment in the energy sector. Some of this demand will be covered by the Russians themselves, but there is still much scope for foreign investment. However, under the leadership of President Putin, the country is re-nationalising its energy sector, with the case of Yukos being the most outstanding example. A limited foreign participation in the oil industry is allowed, while the gas sector remains almost exclusively in the hands of the state. Shell was forced to sell part of its shares in the 'Sakhalin II' project in Russia's Far East to Gazprom, and the partly-foreign-owned TNK-BP had to relinquish its control over the Kovykta gas field in Siberia also in favour of Gazprom. The pipeline system is completely state-owned. Russia also refuses to ratify the Energy Charter Treaty, which would prevent discrimination against EU energy companies in Russia.

Secondly, Russia's oil pipeline system seems insufficient to accommodate growing exports of Russian oil to Europe. For instance, in 2003, Russia's oil industry was producing some 5 mb/day for export, of which only 3.5 could have been transported via the Transneft system and 1.5 mb/day had no other alternative than to go by the far less convenient rail or barge traffic.[26] Although significant investment is necessary to upgrade the pipeline system,

[25] A Strategic View of Energy Futures. By Burrows; Gregory F. Treverton. Survival, Vol. 49, Issue 3. September 2007.

[26] Eurasian Transportation Futures. By John H.Kalicki and Jonathan Elkind. Energy and Security: Toward a New Foreign Policy Strategy. Jan H. Kalicki and David L. Goldwyn (eds.). The Johns Hopkins University Press, Baltimore, MD. 2005. Pp. 150–151.

the Kremlin is determined to maintain the monopoly of the state-owned Transneft, despite some initiatives from the private sector. Gas pipelines are also ageing, which results in no less than an estimated 30 bcm per year being wasted.[27]

Thirdly, doubts have been expressed as to whether Russia would be able to live up to its supply commitments in the future, especially if it is not supported by an influx of Central Asian oil and gas. In addition, natural gas is considerably under-priced in Russia's domestic market, which leads to an inefficient use of gas as well as to a significant growth in domestic consumption, thus limiting export capacity. The state-owned gas monopoly, Gazprom, is also criticised for diverting its attention from its direct business to investments, such as building Olympic facilities in Sochi or expanding its assets in the media market. In January to mid-February 2006, a number of countries, including Serbia, Italy, Romania and Poland, faced disruptions of natural gas deliveries from Russia. These disruptions were not caused by political motives, but rather by Gazprom's temporary inability to provide sufficient quantities of gas.[28] Gazprom's performance has become less spectacular over recent years: last year, its market capitalisation increased by 15%, compared to 60% in 2006.[29]

And last but not least, Russia's energy politicking poses a serious problem for some neighbouring countries and forces them to look for possible alternatives. Energy prices can differ greatly depending on whether a country is considered to be Russia's political ally or not. While profit maximisation is a perfectly reasonable objective, lower tariffs for Belarus or Armenia cannot be explained using the same economic logic. President Putin himself once admitted that Gazprom is a "powerful political and economic lever of influence over the rest of the world."[30] It is difficult not to notice political considerations in temporary supply disruptions for Ukraine and Georgia, following the 'coloured revolutions' in those countries. In 2006, when Polish energy company PKN Orlen outbid Russian competitors in the purchase of shares of 'Mazeikiu nafta', the biggest oil refinery in the Baltic States, the flow of Russian oil to that refinery stopped immediately, referring to 'technical problems'. The flow has not been restored since.

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[27] The Impact of Russia's Emerging Natural Gas Deficit on European Energy Security. Presentation by Michael Fredholm, Defence analyst, Stockholm University, Sweden. Vilnius Energy Security Conference 2007.

[28] Ibid.

[29] Will Medvedev's Ascension Solve Gazprom's Problems? By Pavel K.Baev. Eurasia Daily Monitor. January 14, 2008.

[30] NATO and Energy Security. CRS Report for Congress. By Paul Galis. December 2007.

2.2.4. The Caspian Region

The Caspian Sea resources present a particular interest not only because of their abundance, but also because of their geographic proximity to several key energy actors: Russia, Europe, China, India and the Middle East. It is often suggested that the Caspian Sea has become an arena for a geopolitical struggle.

Azerbaijan has experienced a dramatic growth in oil production, largely thanks to sizeable foreign participation. In 2007, it exported some 0.7 mb/day, mostly to Europe via Turkey. In total, Azerbaijan's oil reserves are thought to be between 7–13 billions of barrels. Kazakhstan is an even more significant oil producer, exporting some 1.2 mb/day with reserves between 9–40 billion barrels. International oil companies are also actively investing in the development of Kazakh resources. Most of Kazakhstan's oil exports go to the West via Russian territory, but some quantities are also directed to the Persian Gulf (via a swap agreement with Iran) and China (via pipeline).[31]

In terms of gas, the Caspian Sea has an even greater potential. In 2005, Azerbaijan, Kazakhstan, Turkmenistan and Uzbekistan produced almost as much natural gas as Canada, while the region's proven reserves are comparable to those of Nigeria.[32] The biggest obstacles to fully exploiting this potential are the reluctance of respective governments to allow foreign investment as well as the lack of transportation options.

3. Energy Alternatives

3.1. DIVERSIFICATION OF SUPPLY

Sir Winston Churchill's famous quote, "safety and certainty in oil lie in variety and variety alone," is perhaps more relevant in today's world than ever. Diversification of supply is perceived as a key prerequisite to energy security. It is important to note that by diversification one should understand not only the variety of suppliers, but also the ability to substitute one energy source for another. Therefore, this chapter aims to discuss both unconventional sources to power our economies and options to access alternative suppliers.

3.1.1. Unconventional Sources of Hydrocarbons

Gas-to-Liquids (GTL). The generation of electricity and heating can be carried out in a variety of ways, ranging from coal-powered stations to nuclear plants. However, our transportation system is much less flexible and highly dependent

[31] US Energy Information Administration data.
[32] Ibid.

on one source – oil. Yet, with the number of automobiles in the world expected to double in the course of the next quarter-century, new technological solutions for our transportation fuel are critically needed. There is tangible progress in developing technology allowing the production of diesel fuel from sources other than petroleum. The Fischer-Tropsch method of converting natural gas into diesel fuel can provide an extremely interesting alternative for diesel-driven vehicles. GTL is also a much more ecological fuel. To bring down the cost of this fuel further R&D is needed, e.g., in catalysis improvements and ceramic membrane technology. Production of GTL fuel can be commercially rational because it could use remote and 'stranded' gas resources that would not be otherwise exploited by the traditional natural gas industry. According to experts, in the medium to long term, GTL "could alter the world energy equation, enabling the movement of large reserves of stranded gas to growing markets, helping to satisfy new environmental requirements and potentially easing political tensions".[33]

Heavy oil and tar sands. The reserves of this unconventional oil are huge and roughly equal to the global reserves of conventional oil: approximately 1 trillion barrels. More than half of the unconventional reserves are located in the western hemisphere, mostly in Canada.[34] Currently, global production of non-conventional oil is just 1.8 mb/day, or 40 times less than conventional oil. However, by 2030, the production is predicted to increase by more than fourfold, with Canada accounting for more than half of the global production (IEA data).

Canada's oil sands represent the second largest bitumen reserve in the world, after Saudi Arabia. Although Canadian oil sand reserves are huge, oil production is still limited[35] due to the high economic and environmental costs of the extraction process. About 80% of the oil sands in Canada (most of which are located in the province of Alberta) are buried too deep below the surface to allow open pit mining. This oil must be recovered by *in situ* techniques. Using drilling technology, steam is injected into the deposit to heat the oil sand, lowering the viscosity of the bitumen. The hot bitumen migrates towards producing wells that bring it to the surface while the sand is left in place. *In situ* technology is expensive and requires certain conditions like a nearby water source. The challenges facing *in situ* processes are efficient recoveries, the management of the water used to make the steam and the

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[33] Technology Development and Energy Security. By Melanie A. Kenderdine and Ernest J. Moniz. Energy and Security: Toward a New Foreign Policy Strategy. Jan H. Kalicki and David L. Goldwyn (eds.). The Johns Hopkins University Press, Baltimore, MD. 2005. P. 432.
[34] Ibid. P. 433.
[35] The National Board Energy estimated oil production at 1.1 mb/d in 2005. By 2015, production is expected to almost triple to about 3.0 mb/day.

co-generation of all (otherwise waste) heat sources to minimise energy costs. Other methods of *in situ* recovery look promising, and are in the research stages of development. Another downside of oil sands extraction is the fact that the process generates five times more greenhouse gas than with conventional oil due to the enormous quantity of natural gas necessary to transform the bitumen.

Unconventional gas. The exploitation of unconventional gas resources, such as tight gas sands, gas shales and advanced coal-bed methane production, is also promising. The US National Petroleum Council estimates that by 2015, unconventional gas sources will account for 20% of the current US domestic gas production.[36]

3.1.2. Transportation Options

Currently, approximately half of all extracted oil is exported (41 mb/day) and the percentage of traded oil will increase with time. Natural gas is much more difficult to transport than oil. Consequently, only 13% of the world's natural gas output has been exported. This share is expected to increase to 22% by 2030 (IEA data). In order to accommodate the rapid growth of oil and gas exports as well as to increase energy security, breakthroughs are needed in the development of additional infrastructure, such as new pipelines and LNG terminals.

Pipelines

Western countries and energy companies have long been pursuing the policy of 'multiple pipelines', particularly when it comes to deliveries of Caspian oil and gas. The existence of different transportation channels provides obvious economic advantages by harnessing market forces. The Russian authorities do not deny the legitimacy of such a policy: at the Caspian Summit in Ashgabat, Turkmenistan, in April 2002, President Putin himself noted "Russia does not have an allergy to the idea of multiple pipelines".[37]

Russia is actively involved in joint projects designed to develop additional pipeline architecture in the Caspian region, naturally, connecting it to the existing Russian grid. Russia considers itself as the indispensable intermediary between Central Asia and the West. As discussed before, it is in Russia's

[36] Technology Development and Energy Security. By Melanie A. Kenderdine and Ernest J. Moniz. Energy and Security: Toward a New Foreign Policy Strategy. Jan H. Kalicki and David L. Goldwyn (eds.). The Johns Hopkins University Press, Baltimore, MD. 2005. P. 440.

[37] Commentary on Part II. By Viktor Kalyuzhny. Energy and Security: Toward a New Foreign Policy Strategy. Jan H. Kalicki and David L. Goldwyn (ed.). The Johns Hopkins University Press, Baltimore, MD. 2005. P. 192.

interest to maintain a long-term commitment of the Caspian states to transport their oil and gas via the Russian grid, thus, in turn helping Russian companies meet their commitments to their Western customers. Reportedly, one third of Gazprom's gas exports to Europe come from Turkmenistan.

Russia's role as an intermediary for Caspian oil exports has been steadily decreasing with the development of a number of pipeline projects in the region:

- Since the **Baku-Tbilisi-Ceyhan (BTC)** oil pipeline was opened in 2006, only small volumes of Azerbaijan's oil are still being transported by the Baku-Novorossiysk pipeline as well as by rail.
- In Kazakhstan, only one third of its oil is exported via the Russian Transneft system. More than half of Kazakhstan's oil exports flow through the **Caspian Pipeline Consortium (CPC)**,[38] a unique pipeline that runs through Russian territory (to Novorossiysk), but is privately owned by Russian, Kazakh and US companies. The capacity of CPC needs to be expanded in order to accommodate the rapidly growing output of Kazakhstan's oil, but negotiations over the expansion are hampered by disagreements between the western members of the consortium and Russia's Transneft, which is determined to maintain its monopoly over the oil pipeline network on Russia's soil.[39]
- Kazakhstan and Western companies have also recently launched a project called the **Kazakhstan Caspian Transportation System (KCTS)**, which will redirect part of the North Caspian oil to the BTC pipeline. The capacity of the BTC will have to be expanded, however, in order to accommodate the influx of the Kazakh oil.
- Yet another alternative route bypassing Russia is the **Baku-Supsa pipeline** (currently facing some technical difficulties), run by British Petroleum (BP) that pumps oil to Georgia's coast to be further transported by tanker.
- Poland, Ukraine, Lithuania, Georgia and Azerbaijan have agreed to build an oil pipeline from the Ukrainian port of **Odessa** to **Gdansk**, Poland, which could accept oil from tankers and thus provide an alternative route for Caspian oil to reach Central and Northern Europe.

With regard to gas, however, Russia has been much more successful and remains a dominant player in the Caspian region. While the west-backed

[38] US Energy Information Administration data.

[39] The Caspian Oil Export Puzzle. By Julia Nanay, Senior Director, PFC Energy. *Energies* magazine No. 12. Autumn 2007.

South Caucasus Pipeline (SCP) is pumping gas from Azerbaijan to Turkey and circumventing Russia (in the same way as BTC does with oil), the major gas producers in the region – Turkmenistan, Kazakhstan and Uzbekistan – are firmly linked to Gazprom's Central Asia–Central (CAC) pipeline system. The 2007 agreement between Russia, Kazakhstan and Turkmenistan reaffirming their commitment to CAC was a serious blow to the hopes of the United States and Europe to install the Trans-Caspian Gas Pipeline (TCGP) from Central Asia to Europe. SCP was originally designed to be just one part of the TCGP and its value for Europe is much less significant without the trans-Caspian link.

The geopolitically significant EU-sponsored Nabucco gas pipeline project is intended to link SCP with Central Europe across the territories of Turkey, Bulgaria, Hungary and Austria. A branch of the pipeline should also span towards Greece and Italy. The project is expected to be up and running by 2013, but it was plagued with financing problems as well as some political disagreements, including between France and Turkey. Another key question is whether the gas supplies for the Nabucco will be sufficient, as the gas reserves of Azerbaijan alone are not significant enough to tangibly contribute to Europe's needs. With Turkmenistan being committed to Gazprom, it is even suggested that Europe should consider an agreement with Iran, the second largest gas producer in the world, to ship some of the Iranian gas through the Nabucco. While such a proposal is sensitive from a political standpoint, one should also bear in mind that – at least in the short term – Iran has little to offer as it consumes almost all of its gas domestically.

The most recent proposal on the alternative route of transportation of Caspian gas to Europe came from Ukraine's Prime Minister Yulia Tymoshenko. She asked for EU support to construct a gas pipeline ('White Stream') from Turkmenistan to Azerbaijan to Georgia then to Ukraine (via the seabed of the Black Sea) and then further on to Central Europe. The European Commission is currently studying the proposal.

Russia's oil and gas export lines are almost exclusively directed towards Europe. Russian gas is delivered by pipelines that run through the territories of Ukraine and Belarus to Central European countries and Germany. Most of Russia's oil is transported either via the Druzhba pipeline system in Central Europe, or by tankers via the Black Sea port of Novorossiysk, the Bosporus or the Bourgas pipeline in Bulgaria.

However, these traditional routes are being revisited by the Russian authorities in the attempt to bypass Central and Eastern European intermediaries. For this purpose, Transneft has recently opened an oil export terminal in Primorsk near St. Petersburg, which redirects oil from the Druzhba pipeline system to tanker lanes in the Baltic Sea. This move has significantly diminished the importance of the Druzhba and resulted in the termination of oil flow to Latvia's seaport of Ventspils and Lithuania's Butinge that were used to export significant volumes of Russian oil.

With regard to the redirection of gas exports, the most significant project is the agreement between Gazprom and two German and one Dutch energy companies to build an offshore North European Gas Pipeline (Nord Stream) from Russia's Baltic port of Vyborg to Germany by 2011. Former German Chancellor Gerhard Schröder was elected as chairman of the project's stakeholders committee. The Nord Stream pipeline will allow Russia to deliver gas directly to Germany, bypassing intermediaries. A number of European nations expressed their concerns about the project, both in terms of environmental risks and because it would leave some of Russia's neighbours with no leverage to offset their absolute dependence on Russia's gas supplies. The environmental concerns are based on the fact that huge quantities of chemical munitions were dumped during and after World War II in the Baltic Sea. Any accident could affect the whole Baltic Sea region.

Gazprom is also looking into new options to export gas via South-Eastern Europe. The Blue Stream project is essentially a direct competitor of the EU's Nabucco, running from Turkey to Central Europe. The Hungarian government has decided to opt for the Blue Stream instead of Nabucco, a decision that was criticised by some EU member states as well as by the Hungarian opposition. In defence of the government's decision, the country's prime minister referred to slow progress in implementing the Nabucco project.

It is often suggested that the westward orientation of Russian and Caspian exports should not be taken for granted. With new and lucrative markets emerging in Asia, Russian energy companies may begin to consider redirecting their trade routes to the East. Kazakhstan oil is already flowing via the Atasu-Alashankou pipeline to China. Turkmenistan has concluded a multibillion-dollar deal with China, which involves a supply commitment of some 30 bcm over 30 years as well as the construction of 7,000 km of pipeline. Russia's Transneft will soon finish the construction of an oil pipeline (Eastern Siberia Pacific Ocean Pipeline – ESPO) to the Pacific coast with a branch to the Chinese city of Daqing. The construction of a gas pipeline from the Kovykta gas field to the Pacific coast was less likely until recently, because this field was mostly owned by the private TNK-BP company and not by Gazprom. However, in 2007, Gazprom managed to take control over the Kovykta field, thus demonstrating Gazprom's interest in the East Asian market. Of course, the development of comprehensive infrastructure from Russia to the Asian markets would take years if not decades, but European countries need to start the preparations for a scenario where Russia has a broader range of export options.

To sum up, the construction of additional pipelines could significantly alter the geopolitical situation in the world, bolstering the independence of the countries in the Caspian region, but the progress is rather slow, particularly when it comes to natural gas pipelines. These are expensive to build: on the average the cost per kilometer is from US$750,000 (onshore) to US$1 million (offshore).[40] The cost factor – some US$20 billion – is hindering the construction of an onshore pipeline connecting vast natural gas resources in Alaska to the rest of the United States.[41] Therefore, the transportation of gas in a liquefied form is becoming an increasingly attractive option.

Liquefied Natural Gases (LNGs)

It is generally agreed that LNG becomes a rational choice when considering transportation over distances further than 4,000 km. LNG accounts for the bulk of the increase in natural gas trade. Currently, less than 10% of gas is shipped in a liquefied form. In absolute terms, the amount of natural gas transported as LNG was 189 bcm in 2005 and it is expected to reach 758 bcm in 2030 (IEA data). In the case of the US, it will rise to 25–30% in 2020 from just 3% in 2004. This will be feasible mostly because new technological solutions drive the cost down making LNGs competitive with pipeline gas.[42] Countries such as Japan and South Korea have switched completely to LNG, importing it mainly from Australia.

Nevertheless, many experts doubt that LNG can be seen as a panacea, because its growth rates are still insufficient and because the economics of LNG involves additional costs – for liquefaction and re-gasification – that are not applied to pipeline gas. Basically, LNG can only contribute to slowing down the increase of Europe's dependency on Russian gas.[43] Moreover, most of the European countries that are overwhelmingly dependent on Russian gas supplies lack LNG terminals and re-gasification capabilities. The Baltic States also lack the link to the European gas grid, and therefore the interconnection between Lithuanian and Polish gas pipelines is of strategic importance in terms of energy security.

Natural gas can also be transported in a compressed form rather than liquefied. At the moment, this method can only be used for short-distance

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[40] Can a "Global" Natural Gas Market Be Achieved? By Donald A. Juckett and Michelle Michot Foss. Energy and Security: Toward a New Foreign Policy Strategy. Jan H. Kalicki and David L. Goldwyn (eds.). The Johns Hopkins University Press, Baltimore, MD. 2005. P. 541.

[41] Ibid. P. 547.

[42] Energy Security and Markets. By Daniel Yergin. Energy and Security: Toward a New Foreign Policy Strategy. Jan H. Kalicki and David L. Goldwyn (eds.). The Johns Hopkins University Press, Baltimore, MD. 2005. Pp. 58–59.

[43] The Russian Dimension and Europe's External Energy Policy. By Dieter Helm. University of Oxford. September 2007. http://www.dieterhelm.co.uk/publications/Russian_dimension.pdf

transportation, e.g. from the Caribbean to the United States. The third option is to convert natural gas into middle distillates (GTL) that could be transported by conventional means, such as oil tankers or rail. GTL technology might offer an appealing and promising alternative to oil in the transportation sector.[44]

3.2. NUCLEAR ENERGY

The current hype over nuclear energy and calls for the 'nuclear renaissance' are based on very compelling arguments. Nuclear energy is almost completely carbon-free.[45] If construction and waste management costs are excluded, it is also very cost-effective: one unit of uranium has a much higher energy density than fossil fuels and it costs only 10–15% of the cost of electricity it produces (when it comes to coal, this figure is 30–40%, and for gas it is 60–85%). Uranium can be stored and transported more easily, thus being much less exposed to market volatilities.[46] And finally, although uranium reserves are concentrated in a handful of countries, most of them are stable and democratic countries.

NATO member Canada is the largest global producer of uranium. As the price of uranium continues to rise, Canada's uranium mining sector is moving to increase production. At present, Canada's uranium production represents 29% of global production, with a total of 11,597 t per year (the total amount of Canada's uranium resources are estimated at 444,000 t). Australia follows with 21%, whereas 9% comes from Niger, Russia and Kazakhstan (Natural Resources Canada, 2005).

The sceptics of the 'nuclear renaissance' usually refer to the following disadvantages:

- The initial cost of building a nuclear power plant and related infrastructure is enormous. It is the single most important factor that prevents the nuclear industry from developing at much faster rates. Most experts agree that, over the period of 2005–2030, overall nuclear plant capacity

[44] Can a "Global" Natural Gas Market Be Achieved? By Donald A. Juckett and Michelle Michot Foss. Energy and Security: Toward a New Foreign Policy Strategy. Jan H. Kalicki and David L. Goldwyn (eds.). The Johns Hopkins University Press, Baltimore, MD. 2005. P. 535.
[45] One gigawatt of nuclear capacity saves approximately 1.5 million metric tons of carbon annually compared to coal and 0.75 million metric tons of carbon compared to gas-turbine-generated electricity – *see* Faux Renaissance: Global Warming, Radioactive Waste Disposal, and the Nuclear Future. By Harold A. Feiveson. Arms Control Today. May 2007.
[46] Energy Security and Climate Policy: Assessing Interactions. OECD/IEA 2007. P. 41.

will increase only modestly: from 367 gigawatts-electric (GWe) to 400–600 GWe,[47] lagging behind the growth rates in global electricity generation. Most of the growth is expected to occur in China, Japan, India, Russia, the United States and South Korea, while European countries, such as Germany, Sweden and Belgium are on their way to phasing out their nuclear sector.[48] On the other hand, technological improvements could considerably ease the burden of construction costs. Modern nuclear power plants can serve much longer – even beyond 60 years – which would allow costs to be spread out over a much longer period.[49]

- The problem of spent fuel disposal is yet to be resolved. Approximately 10,000 t of spent fuel is discharged globally from reactors each year.[50] Some countries, including France, Japan, Russia and the UK, choose to reprocess it, separating plutonium from spent fuel and turning it into mixed oxide fuel (MOX), which can be used in light-water reactors. Another option is interim dry-cask storage of spent fuel, preferred by countries such as Finland, Sweden and the United States. These countries have made tangible progress on long-term or 'final' solutions, such as the underground repository in Olkiluoto, Finland, for high-level spent nuclear fuel placed in copper shells. This technology introduces multiple barriers isolating spent nuclear fuel from nature, but opponents question if this solution really is 'final', as spent reactor fuel remains radioactive for more than 100,000 years.
- Nuclear proliferation concerns many. The physical security of fissile material, particularly in the civilian sector, is a serious problem, which can only increase as new countries enter the nuclear club. The plutonium path, i.e. reprocessing spent nuclear fuel in order to separate plutonium, raises particular questions in terms of both economic rationale and security. Plutonium separation creates stocks of weapons grade plutonium (some 200 t worldwide, with only 6 kg being sufficient to produce one nuclear bomb), which would otherwise have been inaccessible to terrorists lacking sophisticated separation technology.[51]

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[47] Faux Renaissance: Global Warming, Radioactive Waste Disposal, and the Nuclear Future. By Harold A. Feiveson. Arms Control Today. May 2007.

[48] World Energy Outlook 2007. China and India Insights. International Energy Agency.

[49] Getting Power to the People. By Matthew L.Wald. Bulletin of Atomic Scientists. September/October 2007.

[50] Faux Renaissance: Global Warming, Radioactive Waste Disposal, and the Nuclear Future. By Harold A. Feiveson. Arms Control Today. May 2007.

[51] Technology Development and Energy Security. By Melanie A. Kenderdine and Ernest J. Moniz. Energy and Security: Toward a New Foreign Policy Strategy. Jan H. Kalicki and David L. Goldwyn (eds.). The Johns Hopkins University Press, Baltimore, MD. 2005. P. 450.

Regardless of the mixed views on the 'nuclear renaissance', a number of NATO countries seriously consider nuclear energy as an important tool to increase their energy security situation. The United States has radically changed its attitude in recent years, ending years of moratorium on nuclear energy development. Even the EU seems to have changed its negative stance on nuclear energy. Poland and the three Baltic States have agreed to jointly build a new nuclear power plant in Ignalina, Lithuania, to replace the old one, which is due to be closed by 2009. The new Ignalina power plant is expected to become a key factor ensuring the region's independence in terms of electricity supply. The project also envisages the construction of the 'electricity bridge' between Lithuania and Poland, thus ensuring that the Baltic States are no longer Europe's 'energy island'. Currently, electricity sectors in these three countries are a part of Russia's electricity grid.

3.3. RENEWABLES

Renewable energy sources, such as sunlight, wind, water, geothermal and biomass, are a highly preferable option, particularly since they generate little, if any, waste, pollutants or greenhouse gases. However, for most renewables to compete with conventional fuels, either the costs of production have to come down or the cost of fossil fuel has to go up further. Renewables such as geothermal, solar, wind and tidal energy sources are projected to be developed more rapidly (almost 7% of annual growth) than any other type of energy over the next quarter of a century, but they will still make up a small fraction of total energy output.[52] The EU intends to increase the share of renewables in the EU energy mix to 20% by 2020.

Solar power is usually (but not exclusively) associated with photovoltaic energy (PV), which directly converts sunlight into electricity using semiconductor materials such as silicon. PV systems are generally rather costly, and are therefore mostly employed in areas located away from power lines. Nevertheless, capital costs for PV panels have decreased dramatically over the years. The major disadvantage is the relatively low amount of energy delivered by sunlight, requiring large surface areas to collect tangible volumes of energy. The intensity of sunlight also greatly varies in terms of geography, weather conditions and the time of day or year.

Wind energy has been experiencing a rapid growth in recent decades, particularly in countries such as Germany, Spain and the United States. Technological progress has reduced the costs of wind energy to levels that are almost competitive with those of conventional power. In 2005, wind

[52] World Energy Outlook 2007. China and India Insights. International Energy Agency.

machines in the United States generated enough electricity to power a city the size of Chicago, but still it constituted only 0.4% of the country's electricity production. The major drawback of wind energy is the harm wind turbines can cause to wild bird populations.

Geothermal energy harnesses the heat that is produced under the surface of the earth. It can be used in several ways: firstly, hot water from springs can be directed to heating systems of buildings; secondly, steam can be used to generate electricity; and thirdly, stable soil temperatures near the surface can be used to heat and cool buildings. The latter, called geothermal heat pumps, can basically be used everywhere and not only in seismically active areas. Heat pumps are considered to be an extremely promising and completely clean and effective technology, which is projected to grow dramatically in the future.

Currently, hydropower is the most popular of renewable resources. Hydropower is expected to retain its share of approximately 2% of global energy output. The slow rate of growth in the industrialised world is largely related to the fact that there are very few unused opportunities to develop new hydropower projects.[53] Hydropower is also probably the least environmentally-friendly of all renewable sources, as it to a certain extent damages river ecosystems.

Oceanic energy resources, such as tides, waves and thermodynamic flows, present interesting and, possibly, great promise. However, the technologies to convert this potential into a useful form in a cost-effective manner are still in their infancy.

Biofuels present an extremely interesting category, since this renewable resource is the only one so far that competes with oil in powering the transportation sector. Until the present, biofuels have had little impact upon global oil production and consumption, but its production doubled between 2000 and 2005. Biofuels now represent around 3–4% of the total gasoline used. It is forecast that production will almost double again by 2010. Brazil and the United States are indisputably the world's largest ethanol producers.

Biofuels are defined as any fuels derived from biomass. The production of fuel energy from biomass involves a range of technologies including gasification and fermentation. These technologies produce liquid and gas fuels from a diverse set of biological resources, such as traditional crops (sugar cane, maize, and oilseeds), crop residues and waste (wheat straw, rice hulls, cotton waste). The two main types of biofuels are bioethanol and biodiesel. When blended with gasoline or diesel, the use of these fuels requires no engine modification.

While opening new opportunities, biofuels also raise new concerns, in particular in connection with their effects on land use, food prices, small

[53] Ibid.

producers and their accessibility to developing countries. Observers are concerned about trade-offs between lower food security and higher energy security. In the case of sugar cane, net emissions of CO^2 are more than 80% lower than in the case of fossil fuels. However, one has to take into account the fact that bioethanol production requires energy, fertilisers, transformation and transportation, all of them CO^2 emitting activities. The production of biofuels raises a number of other environmental concerns, such as deforestation and overuse of water and fertilizers.

To offset these trade-offs, the second generation of biofuels is being developed. The production of these products, such as cellulosic ethanol, is based on sources that otherwise would be wasted, for instance agricultural, forestry, human and plant waste, as well as crops that can be grown on degraded lands.[54] The technology for the second generation of biofuels is still in its infancy, however.

3.4. ENERGY EFFICIENCY

Energy efficiency should not be perceived as a synonym of sacrifice. By rationalising energy consumption, societies can benefit without having to drastically change their way of life. In the context of the famous 'Three E' triangle, energy (secured supply) – economy (affordable cost) – ecology (environmental attentiveness), it is often claimed that nations cannot achieve all three Es simultaneously; only combinations of two priorities are possible. However, energy efficiency seems to be an exception to this rule as it is beneficial in all respects.

Technological advancements have been contributing rather significantly to making energy use more efficient: the growth of GDP normally outpaces growth in energy consumption by 1–2% points a year.[55] However, this progress merely compensates for population increases and thus does not result in an overall decrease in energy consumption. According to IEA estimates, global energy intensity, i.e. ratio of energy consumption to GDP, will continue to decline at the rate of 1.8% per year between 2005 and 2030, slightly faster than in the past. This acceleration will largely come from developing countries

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[54] The Role of Biofuels. Strategic Comments. IISS. Vol. 14, Issue 1. January 2008.

[55] Speech by Prof. Klaus S. Lackner, Director, Gerry Lenfest Center of Sustainable Energy. XVI Malente Symposium "Energy, Climate, and Future Welfare – Changing Global Dynamics", Lubeck. 8–10 October 2006.

and transition economies that have much more room to apply energy-saving innovations, particularly in terms of thermal efficiency.[56]

The EU leaders have announced the goal of 20% improvement of energy efficiency by 2020. There are a number of ways to reach this goal and exceed it. For instance:

- Efficiency improvements in the power sector. New coal-fired plants have efficiencies of up to 46%, compared to the world average of 30% of the world's average. Raising the world's average to at least 42% by 2030 would save roughly the same amount of carbon as building 800 nuclear plants.[57]
- Transportation efficiency. It is believed that by 2020, the existing technical hurdles will be resolved to introduce commercially viable hybrid cars that achieve more than 70 miles per gallon. However, significant investments and tax incentives are needed. Experts also note that hybrid technologies can be comparable to hydrogen fuel-cell vehicles, both in terms of efficiency and environmental friendliness. Hybrid technology is also more attractive because it does not require an entirely new industrial base.[58] Eventually, the transportation paradigm itself will have to change, switching to hydrogen fuel-cell vehicles. Hydrogen can be extracted from natural gas, coal, biomass, water (via the process of electrolysis) and other hydrogen-bearing substances. Hydrogen is also a completely eco-friendly fuel. However, so far its commercial-scale production is not practical. Apart from technological challenges, such as onboard storage of hydrogen, a shift from gasoline would require an enormous amount of hydrogen. If this amount were produced using natural gas, the global demand for gas would have to double. The use of electrolysis would be even more impractical.[59]
- The promotion of fluorescent light bulbs and phasing out obsolete incandescent light bulbs. The EU announced an ambitious plan to replace these light bulbs in homes by 2009, while Australian authorities plan to do so by 2010. Sub-regional national entities, such as Ontario (Canada) and California (US), intend to phase out these bulbs by 2012. The envi-

[56] World Energy Outlook 2007. China and India Insights. International Energy Agency.

[57] Faux Renaissance: Global Warming, Radioactive Waste Disposal, and the Nuclear Future. By Harold A. Feiveson. Arms Control Today. May 2007.

[58] Technology Development and Energy Security. By Melanie A. Kenderdine and Ernest J. Moniz. Energy and Security: Toward a New Foreign Policy Strategy. Jan H. Kalicki and David L. Goldwyn (eds.). The Johns Hopkins University Press, Baltimore, MD. 2005. P. 435–436.

[59] Ibid. Pp. 436–437.

ronmental impact of such measures would be vast: according to estimates of the US Department of Energy, replacing the most frequently used light bulbs in American homes would be equivalent to taking 10 million cars off the road.[60]

There is considerable potential for co-operation between Europe and Russia to improve energy security in this country. Only 10% of Russia's households have heat and water meters.[61] This co-operation would be mutually beneficial, particularly in reducing domestic gas consumption in Russia. Unreasonably high domestic consumption can significantly diminish the volumes of Russian gas available for the European market.

4. Energy and Security

4.1. THE ROLE OF NATO

The role of NATO in the energy security debate is an open question. Some claim that energy is not a primary theme for the Alliance and that other organisations, such as the EU and the IEA, are better equipped to deal with this challenge. Champions of such views suggest that energy is nothing but one segment of economics and that it should be left to industrialists and not to politicians and especially not the military. Yet, energy is a very special asset that is vital to our societies and has significant security and even direct military implications. Firstly, the examples of energy resources being a significant factor causing military conflicts are abundant and well known. For example, during the Iran–Iraq War (1980–1988), a coalition of nations, mainly NATO member states, took part in a military operation called *Earnest Will*, which was designed to secure the supply of oil. During the operation, the allies engaged in firefights with Iranian troops and captured Iranian vessels mining shipping lanes.[62] Secondly, energy considerations can affect military strategy and tactics: for instance, during WWII, the decision by German strategists to turn south towards Stalingrad was based on the desire to cut off oil reserves in the Caucasus. Thirdly, fuel is an indispensable asset for armed forces, and fourthly, NATO itself has undergone enormous changes after the end of the

[60] Climate Change and Energy Security: The Future is Now. White paper. By Joseph A. Stanislaw, independent senior advisor to Deloitte's Energy & Resources Group. 2007. P. 5.
[61] Presentation by Mr. Anatoly Torkunov, Chancellor, MGIMO University, Russia. IFRI Energy Programme 2008 Annual Conference "The External Energy Policy of the European Union", Brussels. 31 January 2008.
[62] NATO and Energy Security. CRS Report for Congress. By Paul Galis. December 2007.

Cold War, revisiting its agenda and adopting a much broader definition of its mission.

The Riga Declaration is an indication that the issue of energy security is becoming one of the key topics for the Alliance.[63] The Summit in Bucharest as well as other NATO summits and meetings are expected to further elaborate mechanisms specifying the role of NATO in this field.

NATO should play an increasing role in the domain of energy security. The Alliance can provide an added value both due to its capacity in the area of physical protection of energy infrastructure and because it is a unique vehicle for co-operation and co-ordination among members of the transatlantic community. NATO brings on board non-EU countries that are extremely important in terms of energy security: the United States, Canada, Norway and Turkey. In the framework of the Istanbul Cooperation Initiative (ICI) of 2004, NATO has established intensive co-operation with energy rich countries in the Gulf: Bahrain, Qatar, Kuwait, and the United Arab Emirates (UAE). NATO co-ordination mechanisms can and should contribute to enhancing solidarity among the allies in the event of major supply disruption and other outstanding energy security challenges. Some politicians, such as US Senator Lugar, even suggest that energy security be raised to an Article V issue.[64]

4.2. THE ROLE OF THE EU

The EU is generally perceived as being better equipped than NATO to deal with the range of energy security challenges. The EU itself started as an energy project – the Coal and Steel Community, followed by Euratom. The EU is taking steps to create a common European energy policy. In 2007, EU institutions introduced a 2 year (2007–2009) action plan, designed to strengthen the EU's role in energy relations, although the scope of this role is still a subject of discussion among member states. Despite the calls for Europe to speak with one voice on energy matters, this solidarity is yet to be achieved

[63] Paragraph 45 of the Riga Declaration states: "As underscored in NATO's Strategic Concept, Alliance security interests can also be affected by the disruption of the flow of vital resources. We support a coordinated, international effort to assess risks to energy infrastructures and to promote energy infrastructure security. With this in mind, we direct the Council in Permanent Session to consult on the most immediate risks in the field of energy security, in order to define those areas where NATO may add value to safeguard the security interests of the Allies and, upon request, assist national and international efforts." Issued by the Heads of State and Government participating in the meeting of the North Atlantic Council in Riga on 29 November 2006.

[64] NATO and Energy Security. CRS Report for Congress. By Paul Galis. December 2007.

due to very different degrees of energy security in different EU member states. Currently, European nations rely on bilateral agreements with oil and gas suppliers, with little or no co-ordination with other EU members.

Besides the issue of oil and gas supplies, the EU is determined to achieve a breakthrough in energy efficiency and the promotion of renewable energy by setting its famous '20–20–20' target (cutting greenhouse gas emissions by 20% and increasing the share of renewables in the energy mix to 20% by 2020).

The current European Commission is perceived as being liberal and 'pro-market'. It believes that market rules, rather than geopolitical considerations, should be applied in the energy sector. Therefore, the Commission actively promotes the liberalisation and decentralisation of energy markets in Europe, despite concerns expressed by some energy giants, including suppliers such as Gazprom, which is increasing its share in European energy grids. The Commission plans to 'unbundle' ownership of energy assets (by prohibiting power generating companies from owning transmission networks) and/or to create independent transmission systems operators. France, Germany, Austria and four other EU member states oppose such plans, referring to the protection of property rights. Recently, the Commission agreed not to insist on relinquishment of ownership rights provided certain safeguards were introduced, such as guarantees of adequate investment to eliminate bottlenecks. The final decision on 'unbundling' is expected to be reached by June 2008.[65]

EU–Russia energy co-operation has the potential to grow as interdependence between them increases. The EU accounts for 58% of Russia's foreign trade.[66] Russia is also counting on Europe's support in its efforts to become a member of the World Trade Organisation (WTO). At the EU–Russia summit in 2007, Europe and Russia agreed to develop a joint early warning system for energy bottlenecks, but overall the level of co-operation is not sufficient. In particular, the EU is concerned about re-nationalisation trends in Russia and obstacles to foreign investment in its energy sector.

4.3. SECURITY IMPLICATIONS FOR DEVELOPING COUNTRIES

The energy security interests of NATO and EU member states should not be limited to secured access to oil and gas resources. Energy policies in the

[65] Commission supports 'third way' for EU energy regulation. By Simon Taylor. European Voice. 7 February 2008.

[66] Presentation by Mr. Thomas Gomart, Head of the Russia/Newly Independent States centre at the French Institute of International Relations (IFRI). IFRI Energy Programme 2008 Annual Conference "The External Energy Policy of the European Union", Brussels, 31 January 2008.

developing world also have significant ramifications for global security. Skyrocketing prices for oil and other energy commodities will have a much more damaging effect on energy 'have-nots' in the developing world, such as Pakistan. It is estimated that the high-price future would cost Pakistan one tenth of its GDP (US$400 billion) over the next quarter of a century.[67] Rising prices jeopardise Pakistan's economic development and increase the potential for social explosion in this already fragmented country, which possesses nuclear weapons and has terrorist bases on its territory.

Energy 'haves' in the developing world face different challenges. Vast oil and gas resources often result in internal inequality, increased corruption and even civil unrest. In mid-2007, civil unrest in Nigeria resulted in 750,000 barrels per day of production being shut off.[68] Energy resources can also increase the resistance of ruling regimes to demands for democratisation and transparency. Iran's vast oil and gas resources have clearly helped its ruling regime to offset international pressure and render the US and UN sanctions virtually ineffective. The UN Security Council's refusal to impose oil- and gas-related sanctions has been linked to the fear of further increases in the price of these commodities. Sudan's energy resources and ties with China are reportedly helping the local warlords to receive military equipment.[69]

5. Conclusions

Generally, there are two ways of addressing the challenge of energy security: a reactive approach and a pro-active one. The former focuses on dealing with the existing global energy landscape and finding ways to ensure we have sufficient supplies of oil and gas to keep our economies going. The pro-active approach implies that a long-term strategy is also necessary to facilitate (and even push for) the transition to the post-carbon future. Both approaches must be considered when shaping energy policies and strategies.

The bulk of the problems associated with energy security derive from the fact that instead of being treated just like any other sector of the economy, energy is often subject to extensive state control. In fact, around 90% of

[67] A Strategic View of Energy Futures. By Burrows; Gregory F. Treverton. Survival, Vol. 49, Issue 3. September 2007.

[68] World Energy Outlook 2007. China and India Insights. International Energy Agency.

[69] Energy, Climate and Security Concerns of the Future. A speech by Professor John M. Deutch, Massachusetts Institute of Technology. XVI Malente Symposium "Energy, Climate, and Future Welfare – Changing Global Dynamics", Lubeck. 8–10 October 2006.

global oil and gas reserves is in state hands.[70] If left to market forces and competition alone, it is very likely that many acute issues would disappear altogether. The European Commission clearly shares this view, but it is faced with suppliers that prefer completely different game rules and efforts to impose these principles from the outside can be counterproductive.

Therefore, while trying to promote the notion of liberalising the energy market, the Euro-Atlantic community has no other choice but to continue playing old geopolitical games. In the short term, it needs to augment its solidarity to ensure that none of its members is exposed to energy blackmail. Multiple pipelines, LNG terminals and grid interconnectors are all extremely important in this regard. The efforts to diversify the supply routes should not be interpreted as being directed against a particular country; indeed, the Nabucco pipeline, for example, is not designed to deliberately circumvent Russia – it is, in fact, the shortest route from the Caspian region to Central Europe. Diversification of supply routes also has another significant security implication, as it diminishes motivation for terrorist attacks on energy infrastructure.

Having said that, one should also bear in mind the fact that a liberalised market will not solve every problem and a certain degree of governmental involvement will be necessary. Often market forces are too focused on short-term profits instead of on generating sufficient stocks in the event of a supply disruption. The diversification of supply is not a priority either: private companies do not mind buying resources from a single supplier as long as prices are acceptable. Yet another negative side of oil market liberalisation is that the excess oil capacity has diminished to a level that would not be sufficient to protect Western countries in case of a major oil supply disruption.[71]

Maintaining sufficient emergency oil stocks is another important aspect. The IEA requires its members to accumulate sufficient emergency oil stocks to compensate for supply disruption for at least 90 days. However, this requirement is not being strictly obeyed. The US Strategic Petroleum Reserve (SPR) contains approximately 670 million barrels of oil, but with projected rates of consumption, by 2020, even a reserve of one billion barrels would only be able to cover 57 days of oil imports. Experts suggest reinstating the original requirement of the IEA to have a cover for at least 90 days. The private sector also must have incentives to increase its reserves and excess

[70] The Russian Dimension and Europe's External Energy Policy. By Dieter Helm. University of Oxford. September 2007. http://www.dieterhelm.co.uk/publications/Russian_dimension.pdf

[71] Energy and Security: Toward a New Foreign Policy Strategy. H. Kalicki and David L. Goldwyn (eds.). The Johns Hopkins University Press, Baltimore, MD. 2005. P. 2.

capacity. The SPR should be used more frequently to address even short-term disruptions.[72] Also, the mechanism to employ the SPR has to be more flexible. Even a global strategic petroleum reserve, operated by the IEA, should be considered. Such a reserve could provide a tool to effectively counter-balance OPEC.[73] Membership of the IEA should not be limited to OECD countries. A number of key countries, including China, India, Indonesia and Mexico, need to be involved as well. Finally, a similar solidarity arrangement could be considered in relation with natural gas.

The interests of the suppliers must also be taken into account. Some experts even suggest that low oil prices could be counterproductive for our security as they might destabilise the situation in some key producing countries such as Saudi Arabia. There is a clear need to strengthen the supplier–consumer dialogue through the International Energy Forum (IEF) or through direct contacts between the IEA and OPEC.

Yet, everyday concerns about the flow of hydrocarbons must not outshine the long-term vision of 'life after oil'. Without breakthroughs in clean energy technology, global economic growth will soon become simply unsustainable, particularly in terms of the environment. The IEA has estimated that if the international community were to adopt a set of policies designed to decrease reliance on fossil fuels by promoting alternatives such as nuclear energy and renewables, total energy consumption by 2030 could be 11% lower compared to the 'business as usual' scenario. This amount is roughly equivalent to China's entire current energy consumption.[74] Particular attention must be paid to diverting investment from traditional R&D focused on hydrocarbons to alternative technological solutions in order to avoid being locked in fossil-fuel technologies for decades.

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[72] On the other hand, a prominent energy expert Daniel Yergin warns that there is a danger of using emergency stocks to react to oil or gas price fluctuations: it could distort the economic logic and discourage investments and new technological solutions.

[73] Building Strategic Reserves. By David L. Goldwyn and Michelle Billig. Energy and Security: Toward a New Foreign Policy Strategy. H. Kalicki and David L. Goldwyn (eds.).

[74] World Energy Outlook 2007. China and India Insights. International Energy Agency.

ENVIRONMENT, SECURITY, AND DEVELOPMENT CHALLENGES IN THE 21ST CENTURY*

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Madame Speaker, excellencies, ladies and gentlemen, distinguished guests, friends and colleagues, It is a pleasure to be speaking here today in connection with the Environment and Security initiative, for which I have had the pleasure of serving as chairman during 2007.

Usually when I speak on behalf of ENVSEC, the emphasis is on presenting the initiative to partners, and explaining our activities, in the most diplomatically appropriate manner. As I understand it, however, today's meeting has a somewhat different purpose: it focuses on cutting-edge research, analysis, and policy dialogue concerning security and environmental issues. I will therefore present – perhaps somewhat provocatively – what I would suggest are the present and future challenges facing the guardians of the global commons – the custodians of environmental sustainability, security, and development – in the 21st century.

As trans-national governance institutions, the security and international development architecture constructed after World War II served the NATO signatories, and their neighbours, quite well. The NATO security blanket protected and bound together prosperous democracies, and gave less prosperous countries (like Turkey) a development and security model that became increasingly worthy of emulation. The IMF, World Bank, the GATT/WTO, and the UN provided reasonably effective multilateral instruments for managing global economic and development problems, forestalling the reappearance of the beggar-thy-neighbour economic policies of the inter-war period. While recognition of the significance of trans-national environmental problems was slow to emerge, the global governance architecture did ultimately respond by drafting conventions protecting international waters, the ozone layer, and other constituent elements of the global environmental commons.

The promise of economic progress and collective security in the US and Europe reached its zenith in the early 1990s. Reformers in the eastern bloc

* These remarks do not represent an official view of the United Nations Development Programme

S. Stec and B. Baraj (eds.), Energy and Environmental Challenges to Security,

abandoned Marxist-Leninism and embraced liberal democracy and collective security, within the framework of NATO, the OSCE, the WTO, and the EU. Developing countries like China, India, and Brazil increasingly opened their economies and societies to the forces of globalisation – and were rewarded with rapid growth in trade and capital flows. The economic growth that ensued lifted billions of people out of poverty.

The promise of the liberal democratic "new world order" was also a promise of multilateralism. The Persian Gulf War of 1990–1991 not only received the backing of the UN Security Council and USSR: it ended with the recognition by the first Bush Administration that its multilateral mandate did not extend beyond the liberation of Kuwait. NATO expanded into the former USSR without engendering serious objections from the Russian Federation – due in part to Moscow's belief that its interests could be defended multilaterally, via Russia's Security Council seat and its position in OSCE. The implementation of the Montreal Protocol, which must surely be regarded as one of the most successful exercises in global environmental governance ever, brought multilateralism into new areas of the global commons. Concerns about climate change gave rise to the Kyoto Protocol.

It seemed to many observers that the forces of global capitalism were being effectively guided and regulated by wise technocrats in Washington, New York, Geneva, and Brussels. Development, democracy, security, and environmental protection seemed to be within reach for anyone willing to sign on to the "new world order" and the "Washington consensus" that underpinned it.

The financial crises that hit the Asian emerging markets in 1997, and then spread to Russia, Turkey, and Argentina, were the first signal that not all was right in the post-Cold War world. This emerging market contagion demonstrated that the wise technocrats in Washington had neither the intellectual nor financial wherewithal to gainsay market traders in Djakarta, Moscow, and Istanbul – not to mention New York, London, and Tokyo. Fortunately, most of the affected economies recovered fairly quickly. In some cases, this was due to the acceptance of the wise advice – and conditionalities – of technocrats in Washington and Brussels. But in other cases – such as Malaysia – economic recovery occurred despite the introduction of capital controls. For Russia, recovery also resulted from higher energy prices – heralding the start of an era in which growth in the demand for fossil fuels would perennially outpace growth in supply. The emerging "anti-globalisation" movement, growing protests against the social and environmental consequences of free trade, and developing country objections to the global intellectual property regime – which were seen as having life-or-death consequences for Africa's prospects for combating the AIDS epidemic – these were uncharted waters for the wise technocrats in Geneva negotiating the WTO's Doha round.

September 11, 2001 was the next wake-up call, with two very serious implications for the global security system. First, it showed that even the world's dominant military power is vulnerable to asymmetric warfare. Second, September 11 consolidated a unilateralist rebalancing of US foreign policy. The invasion of Iraq without a UN Security Council resolution, the rejection of the Kyoto Protocol, the instrumental treatment of the global non-proliferation regime, the US failure to accede to the International Criminal Court – all this signified the rejection of multilateral solutions to global security problems by the world's hegemon. If the world's largest country would not play by the rules of multilateralism, why should others do so?

Definitive assessments of unilateralism should be left to historians. But however these assessments conclude, the present-day implications for global governance do not seem to be particularly sanguine. International military engagements seem trapped in quagmires in Iraq and Afghanistan, unable to either decisively defeat the insurgencies or to withdraw without risking worse instability and insecurity. In contrast to the 1990s, Washington can not count on strong support from the UN or NATO – organisations whose search for cohesion and direction continues. America's relatively weak fiscal and external positions – reflecting the costs of the wars in Iraq and Afghanistan, and the American consumer's unwillingness to face the consequences of $100/barrel oil – has put strong downward pressures on the dollar. The current account deficit and the ascendancy of the Democrats in the US Congress may have hammered the final nails into the coffin of the WTO's Doha round, and with it medium-term prospects for further trade liberalisation.

America's changing position is mirrored in Russia's economic and political rebound in the post-Soviet space, as well as in the continuing strong growth of China, India, and other leading emerging economies. This new correlation of financial forces is reducing the Bretton Woods institutions' role in the developing world – in many Asian and African countries, China has supplanted the World Bank and other bilateral donors to become the largest supplier of development finance. And in contrast to wise technocrats in Washington, Brussels, and other NATO capitals, policy makers in Beijing often seem more interested in obtaining raw materials than in promoting good governance. Moreover, the dollars flowing into bank accounts in Beijing, Moscow, Delhi, and Brasilia are being channelled into sovereign wealth funds – with the potential to flood the capital markets with liquidity in response to geo-political, rather than financial, signals. The precedent set by the Bush Administration's 2006 veto of the sale of strategic port facilities in New York City Harbour to Persian Gulf purchasers shows that the significant investments in "Western" capital markets by "Eastern" sovereign wealth funds could easily meet protectionist responses.

From a development perspective, the current global political economy has a number of favourable dimensions. High prices for energy and primary products are providing many developing countries in Africa, Asia, and Latin America with the terms-of-trade gains needed to boost economic growth and reduce poverty. Hundred dollar-a-barrel oil also promotes energy conservation and investments in renewable energy. The recasting of global financial balances and their own loss of relevance are precipitating overdue reform discussions in the IMF and World Bank, concerning their governance structures and policy paradigms. All the world's major players remain heavily reliant on one another for energy, capital, and market access.

Still, every silver lining has its cloud. The above diagnosis, if correct, suggests that global economic, development, security, and environmental trends are currently headed in directions which, if not wholly uncharted, are at least fraught with uncertainty. Global economic growth continues, but its momentum is flagging under the burden of high energy prices, rising inflation, and the strains on the US and European financial systems revealed by the sub-prime mortgage crisis. The dollar's drop is weakening the balance sheets of leading global financial institutions – in Asia and Europe, as well as in the US. A wholesale flight from the dollar by investors who have decided enough is enough, and the inflationary issuance of additional Euros, yen, and yuan by central banks seeking to stave off a global financial panic, can not be ruled out. Should this occur, the effects on the global economy – and on economic prospects for the developing world – would be difficult to predict.

We know from the Stern and IPCC reports that the prevention of unprecedented warming in the earth's environment will be extremely difficult. While we do not know what its consequences will be, we know that catastrophic failures of the vital ecosystems are among the possibilities. What does the above suggest about mitigating and adapting to climate change?

First the good news. As argued earlier, we seem to have entered an era in which growth in the supply of fossil fuels will find it difficult to keep pace with growth in demand. High energy prices are a *sine qua non* for conservation and investment in alternative energy sources. We do have a global climate change regime in place – the Kyoto framework – which at least in Europe has been transposed into national policies, via the EU's emissions trading system (ETS). Kyoto has accelerated the development of carbon markets that are helping the private sector to internalise the externalities of climate change, putting the invisible hand of the market behind efforts to reduce global warming.

Unfortunately, the Kyoto Protocol has not been ratified by the US, nor does it address the significant quantities of greenhouse gases emitted by China, India, and other large, rapidly growing developing countries. Carbon markets and the ETS have yet to deliver on their promise of green investments. Carbon taxes – a promising instrument for internalising the externalities of climate change – have not yet been introduced on a significant scale. And while high oil prices are boosting the use of renewables, they have also produced a global coal boom – with all its attendant side effects, in terms of greenhouse gases and sulphur dioxide emissions, and mine safety. High fossil fuel prices may also lead to a resurgence of nuclear energy – a power source that deeply divides both the environmental and security communities. And increased reliance on wind and hydropower is not without its unintended environmental consequences on watersheds and biodiversity.

What, then, might be the way forward? While I do not pretend to know the answers to these predicaments, I would like to suggest four theses for your consideration.

First, the economic, developmental, security, and environmental problems we face have a truly global character. An effective response must be equally global in character.

Second, this global response must be profoundly multilateral, and reflect the inter-dependencies between development, security, and environmental paradigms. It must seek to increase the effectiveness of those multilateral bodies – the UN, the IPCC, the Bretton Woods institutions, the WTO – that have mandates to design and implement this response. A thorough investigation of the factors behind the success of the Montreal Protocol – with an eye toward replicating them in the climate change context – would seem particularly important in this respect.

Third, a greater willingness to subordinate short-term national interests to the imperatives of managing the global commons is needed. Such a willingness must underpin the many compromise solutions needed to make the global governance architecture more effective. The importance of compromise is apparent, for example, in the debates on reform of the UN and the Bretton Woods institutions. Likewise, negotiations on the post-Kyoto climate change regime could focus on creating a framework that takes into account both the stock and the flow of greenhouse gas emissions, that brings all the leading carbon producers under a single global regulatory framework, and which internalises the positive externalities of carbon sinks.

Finally, commitment to the effectiveness of the global climate change regime must be matched by an equally deep interest in the expansion and deepening of carbon markets. No amount of reports or edicts can be expected to rival the profit motive for generating technological change. It is only when inventors, venture capitalists, banks, traders, and energy companies have invested trillions of dollars in climate change adaptation and mitigation, that we will have turned the corner on global warming.

I must conclude by apologising for the length and perhaps excessively provocative tone of my remarks. It may well be that the diagnoses and responses presented here are misconceived. However, I would suggest that these are the questions we should seek to answer.

Thank you very much for your attention.

KEY NOTE ADDRESS

ENVIRONMENTAL SECURITY CONCERNS: SOURCES

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Abstract: We are witnessing a new phenomenon in the global arena: the environmental dimension to security issues. It reflects those environmental factors – water, soil, vegetation, climate, and whatever others are prime components of a nation's environmental foundation – that ultimately underpin all our economies and hence our societies and our political stability. When these environmental resources are degraded, our security declines too. In fact, any adverse environmental factor can serve as a source of economic disruption, social tension and political antagonism. While it may not always trigger outright confrontation, it helps to destabilize societies in an already unstable world – a world in which we can expect the destabilizing process to become more common as growing numbers of people seek to sustain themselves from declining environments. This thesis is illustrated with particular reference to three issues: water supplies (and scope for water wars), energy demand/supply, and a host of other environmental problems with widespread impact such as desertification, global warming and population/poverty pressures. Plainly we need to move on from national security to collective security.

Keywords: Water shortages, energy demand and supply, energy efficiency, desertification, resource degradation, environmental refugees, environment/conflict linkages

> *Few threats to peace and survival of the human community are greater than those posed by the prospects of cumulative and irreversible degradation of the biosphere on which human life depends. True security cannot be achieved by mounting build-up of weapons (defence in a narrow sense), but only by providing basic conditions for solving non-military problems which threaten them. Our survival depends not only on military balance, but on global cooperation to ensure a sustainable environment.*

Brundtland Commission Report, 1987

> *If a nation's environmental foundations are degraded or depleted, its economy may well decline, its social fabric deteriorate, and its political structure become destabilized as*

growing numbers of people seek to sustain themselves from declining resource stocks. Thus national security is no longer about fighting forces and weaponry alone. It relates increasingly to watersheds, croplands, forests, genetic resources, climate stability, and other factors that, taken together, are as crucial to a nation's security as are military factors.

Norman Myers, 1996.

Sustainable development is a compelling moral and humanitarian issue, but it is also a security imperative. Poverty, environmental degradation and despair are destroyers of people, of societies, of nations. This unholy trinity can destabilise countries, even entire regions.

Colin Powell, U.S. Secretary of State, 1999

This paper seeks to assess the latest state of play in the Environmental Security arena, and to summarize how the issue has developed since its first emergence in the mid-1970s. After it became established in the mid-1980s, notably through the Brundtland Report, there was somewhat of a lull in professional assessment until the mid-1990s when it attracted renewed interest. Moving on to today, what is "new" – and how could it become newer still?

I first raised the concept of ES in the mid-1970s when I wrote a report for the Organization for African Unity on the Ogaden war between Ethiopia and Somalia. The war had been caused in major measure by deforestation and soil erosion in the Ethiopian highlands, plus runaway population growth and poverty, which induced widespread famine followed by a mass migration from the highlands toward the lowlands and hence toward the Ogaden – which Somalia viewed as prelude to an invasion.

This opening presentation of the concept was confirmed in the late 1970s by the architect of the 1967 Israeli victory in the Six Day War, General Moshe Dayan. He assured me that a prime motivation for the war, on top of General Nasser's manoeuvrings, was the threat by Syria and Jordan to sequester a good part of the River Jordan's flows – a threat viewed by Israel as a sufficient *casus belli*. Around the same time, moreover, Ethiopia was asserting its plan to divert much of the Blue Nile to irrigate extensive sectors of its highlands. Egypt promptly announced that if this occurred, it would immediately declare war.

Thus the new phenomenon of Environmental Security reflects those environmental factors – water, soil, vegetation, climate, and whatever others are prime components of a nation's environmental foundations – that ultimately underpin all our economies and hence our political stability, even our societies (Myers, 1996). When these environmental resources are degraded, our security declines too. While the problem may not always trigger outright confrontation, it helps to destabilize societies in an already unstable world – a world in which we can expect the destabilizing process to become more common as growing numbers of people seek to sustain themselves from declining environments (Martin, 2006; Rees, 2004).

1. Water: A Strategic Sector

As mentioned above, water – or rather water shortages – may well prompt future tensions, conflicts and outright violence in numerous parts of the world. Water has long served as a key element of environmental security. The first recorded instance was 4,500 years ago when two Mesopotamian city states went to war in what is now southern Iraq. Today's world is "new and different" to an extent we can barely comprehend. During the past half century there have been more than 450 water-related disputes of hostile sorts, and on 37 occasions rival countries have fired shots, blown up a dam, or undertaken other forms of violent action (Postel, 2005; Gleick, 2004).

At least 261 of the world's major rivers are shared with other countries. Their river basins take up more than 45% of Earth's land surface, they account for 60% of the world's freshwater supply, and they supply nearly 40% of the world's population with water for domestic use, agriculture, industry, hydropower and other salient purposes. Two thirds of water withdrawals are used to produce that basic commodity, food. In Southern Asia, water shortages rather than land shortages look likely to restrict plans to expand agriculture. In China over 400 million people live in regions with water scarcity, to go with 300 million in India, for a combined total of at least 700 million people, or more than twice as many as in the United States and Canada combined. Worldwide at least 180 million tonnes of grain, around one tenth of the global harvest, are produced by depleting water supplies. Since the average world grain consumption is one third of a tonne per person per year, this means that almost half a billion people are being fed by grain produced through unsustainable use of water. This applies especially to Asia, which supports roughly three fifths of the world's people but possesses little over one third of the world's renewable freshwater (Gleick, 2004).

Already there are hefty pushings and shovings between Turkey on the one hand and Syria and Iraq on the other hand over the Rivers Tigris and Euphrates. The same applies to India and Pakistan over the Indus; to India, Bangladesh and Nepal over the Ganges; to Brazil and Argentina over the Rio de la Plata; and to nations sharing the Mekong's river basin. Water wars, anyone?

At least 1.1 billion people do not enjoy one of the most basic human rights, viz. safe drinking water. Many have no more water for drinking, washing and cooking each day, than a rich world person uses with every flush of the toilet. The 1.1 billion total is much the same as it was in 1990 despite some efforts to fix the problem (part of the difficulty lies with population growth of 1.3 billion people since 1990). Water-short people still amount to one in five of the global population of 6.6 billion and the year 2025 could see a whopping one out of three persons enduring water shortages.

The water challenge has been designated one of the Millennium Development Goals (MDGs), proclaimed by the world's governments in 2000, urging that the proportion of water-short people be halved during the period 1990–2015. This would require an additional 300,000 people a day gaining access to safe water between 2005 and 2015 – an effort that would still leave almost 800 million water-short people.

To supply safe water for all would cost at least $15 billion a year on top of what is currently spent. Suppose that the rich nations pick up one third of the bill (a customary proportion for such-like global arithmetic), or $5 billion of the extra $15 billion, the other $10 billion being produced by the developing nations; then the rich world's 800 million taxpayers would each be paying $6 per year – or the equivalent of a Coke every 4 months.

2. Energy: Demand and Supply

Fossil fuels remain by far the largest source of our commercial energy, accounting for around 90% of the world's supplies. The most important is oil, accounting for 45% of all fossil fuels (not surprisingly when 1 t of oil generates energy equivalent to the output of 660 horses over 24 h). Yet the price of oil has jumped to unprecedented levels, from $50 or so a year ago to as much as $75 a barrel – a surge that looks likely to continue until it tops $100 with every prospect of staying there. This is the biggest oil price shock since the OPEC disruptions of 1973 and 1979, and whereas those two have eventually featured price declines in real terms, the present price rise may well persist indefinitely.

Why this new shift in oil markets? One reason of course is the Iraq war with its destabilizing impacts on much of the Middle East. Another, and probably a bigger reason in the long run, lies with the insatiable thirst for oil on the part of China. In the early 1990s China produced as much oil as it consumed, but by 1993 the country started to rely primarily on imports. In 2006 China produced 3.7 million barrels of oil a day and consumed 7.5 million barrels. China has become the world's second largest oil consumer, and given China's prodigious plans for industrial expansion, that, as they say, is only the start.

These radical changes in the global oil budget are especially relevant to developing countries. During the period 1994–2006 world oil consumption grew by 21%, with several newly affluent countries showing particularly large growth, 78% in India and 134% in China. Energy demand in e.g. the emerging economies of developing Asia is projected to more than double between 2003 and 2025, by which time the developing world could account for 56% of world energy consumption, having averaged an annual growth rate of around 3.0% per year. When we add in the huge increases projected in much of the developing world, we find that global demand for oil could reach 120 million barrels per day by 2025, way beyond the 84 million barrels in 2006. But let us be wary of simple projections: if the average Chinese ever uses as much oil as the average American, China will require more oil than the entire world produced each day in 2005 (Lovins, 2004, 2005).

Thus the premium on alternative sources of energy, notably the "clean and renewables" (C and Rs). The global output of solar cells soared by 45% in 2005 (a jump of 3,654% over 1990), and wind power zoomed by 24% (2,988%). This contrasts with oil, which increased by only 1.3% (22%). The marketplace value of C and Rs overall – not only solar energy and wind power but wave and tidal power, fuel cells and micro-turbines – could well grow from under \$40 billion in 2005 to at least \$167 billion by 2015. (Similarly the market for cleaner vehicles is projected to grow from \$2 billion in 2000 to \$48 billion by 2010.) Although C and Rs such as wind and solar currently meet only 2% of global energy demand, the technical potential of these inexhaustible energy sources far exceeds total energy use.

Foremost among the C and Rs is wind power, with 60,000 MW of generating capacity in 2005 (a 30-fold increase since 1990). The cost of wind-generated electricity has fallen by more than four fifths over the past 2 decades, until in many regions it is lower than that of new fossil fuel plants. Indeed wind power may soon rank as the cheapest large scale energy source worldwide, even though today it generates less than 1% of all electricity. Europe has more than two thirds of global wind capacity, and two fifths of that is found in Germany – a country aiming to reduce GHG emissions by 40% by 2020. Denmark already generates 21% of its electricity through wind power, and aims to make it 50% by 2030. Among developing countries India is the leader for wind power, with over 4,400 MW of generating capacity. But the world's greatest potential for wind power probably lies in the American Great Plains, where a wind turbine occupying one tenth of a hectare can produce \$100,000 worth of electricity per year and earn the farmer \$2,000 in royalties. In Iowa certain farmers now earn far more per hectare by harvesting wind power instead of corn – though the two can operate admirably side by side.

Notwithstanding the above, the most productive way for us to meet our energy needs is by making better use of what we have. Compact fluorescent light bulbs use 70–80% less electricity than standard filament bulbs for the same light output. Then there is the case of household appliances left in "standby" mode, notably computers, TVs, videos, microwaves, etc., all of which "standby-ing" costs America more than \$1 billion per year. New efficiency standards on these household products can often reduce energy demand by three quarters. The energy needed to keep a conventional building warm in winter can be cut by half. Specially coated glazing can slash heat loss from a building sevenfold compared even with double glazing (Lovins, 2005). The European Union has called for energy-efficient modes of office and street lighting to be adopted by 2008 and in private homes by 2009. Within 8 years the switch to fluorescents could save European consumers as much as $8 billion (Spongenberg, 2007). If everybody in the world took this energy- and money-saving step ($50 per bulb lifetime), the global slashing of electricity would allow the closing of 270 coal-fired power plants out of 6,500 such plants in the world (in the U.S., possibly as many as 80 plants closed, out of 627). During the first 4 months of 2007, Americans bought 37 million fluorescents, worth a cut in carbon emissions equivalent to taking 260,000 cars off the road (Brown, 2007).

All in all, then, we should not view our energy future as a major problem. It could be an immense opportunity – but we are not likely to grasp this opportunity as long as fossil fuels are subsidized to the extent of at least $130 billion per year worldwide (Myers and Kent, 2001). What could get us to progress beyond artificially cheap prices and thus into a "beyond fossil fuels" era? Probably the energy consuming public, and political leaders too, will not take this step until they are pushed into it by episodes of climate change. These episodes are likely to be so deeply disruptive that they serve as the single biggest factor in our energy futures.

3. Other Environment/Security Linkages

What has emerged because of water deficits applies also to deforestation, soil erosion, desertification, over-fishing, and a host of other environmental problems with widespread impact. By virtue of its capacity to trigger famines and mass migrations, desertification often serves as a recipe for political instability (e.g. Algeria, Chad), for tensions between neighbouring countries (e.g. Zimbabwe, Botswana), and even for armed conflict. It is surely not coincidental that in the Sahel zone of Africa, not a single government survived the droughts of the 1970s and 1980s, several fell twice over, and a few are moving toward still further collapse. Desertification and drought affects two fifths of the Earth's land surface and threatens the livelihoods of 1 billion people in more than 110 countries (and another 1 billion are at risk). Yet anti-desertification measures (proposed more than 2 decades ago) would cost only $20–40 billion per year with savings for agriculture alone worth $65 billion per year (in 2005 dollars) (Adeel et al., 2007; Myers and Kent, 2008).

The desertification case points up a basic qualifier: we must be careful not to overstate the case. Not all environmental problems lead to conflict, and not all conflicts stem from environmental problems. Far from it. Indeed it is rare for linkages to be directly and exclusively causative. But there is enough evidence for the central thesis to stand. Similarly, while environmental phenomena contribute to conflicts, they can rarely be described as sole causes. There are too many other variables mixed in, such as inefficient economies, inflexible political structures, oligarchical regimes, unjust social systems and repressive governments, any of which can predispose a nation to instability – and thus, in turn, make it specially susceptible to environmental problems. For instance, absolute poverty afflicts 1.3 billion people, or one in five of humankind. Impoverished people become desperate people, all too ready to challenge governments through e.g. support of guerrilla groups as in the Philippines and Peru. At the same time, impoverished people feel driven by their plight to overwork their croplands, to clear forests and to cultivate drylands and mountain slopes for additional croplands, all of which trigger soil erosion and other environmental ills, and result in poverty compounded.

In many instances, the environment/conflict linkages are readily apparent. In other cases, the impact is more deferred and diffuse, as in the case of species extinctions and gene depletion, with all that means for genetic contributions to agriculture, medicine and industry. Probably the biggest threat of all will surely prove to be climate dislocations as global warming imposes basic shifts in weather patterns, undermines agriculture and health, and generally disrupts the world we have long known. Build-up of carbon dioxide and other greenhouse gases in the global atmosphere will, if continued as projected, engender far-reaching disruptions for temperature and rainfall patterns. As a result of possibly warmer and drier weather in its grainlands, leading to severe and persistent droughts, the United States' great grain belt could become unbuckled. Conversely, Russia and Ukraine, possibly enjoying better rainfall in part of their territories, could become major suppliers of surplus food. India could conceivably find itself better off in rainfall terms, Pakistan worse off – in turn, affecting the relations between these two traditional adversaries. There will be many other "winners" and "losers" in a greenhouse-affected world, with all manner of destabilizing repercussions for a world already experiencing other kinds of environmental turmoil. It will be a world in which many of us will end up as direct losers and in which all of us will be indirect losers.

4. Environmental Refugees

Of the nearly 1 billion people added to the global population during the 1990s, a good proportion were among communities with a cash income of $1 per day or less. They will have included the people most likely to be subsisting, or rather struggling to survive, in environments too wet, too dry or too steep for sustainable agriculture. In Sub-Saharan Africa, these environments needed to support an extra 150 million people during the 1990s, and in India 165 million. Many of them will join the throngs of environmental refugees, estimated to have totalled 25 million in the mid-1990s – or a total greater than all other forms of refugees put together, viz. people fleeing political oppression, religious persecution and ethnic troubles. This however is a cautious and conservative figure. Scattered throughout the developing world in the mid-1990s were 135 million people threatened by severe desertification, and 650 million people suffering acute water shortages. While some of these people would have been included in the 25 million figure, many could well have been driven to migrate without being counted as environmental refugees.

The eventual total of environmental refugees could soar to at least 250 million and conceivably twice as many in a globally warmed world. Extensive communities will be overtaken by sea-level rise and coastal flooding, by disruptions of monsoon systems and other rainfall regimes, and by droughts of unprecedented severity and duration. Among regions affected would be the low-lying coastal plains of China and India, and delta areas such as the mouth of the Nile and the whole of Bangladesh, plus drought-prone Sub-Saharan Africa. Certain island nations of the Pacific and Indian Oceans, while featuring only small populations, would be entirely eliminated.

In short, large numbers of destitute people could soon start to pose entirely new threats to international stability. This would be especially the case if the refugees were to feel they can best find sanctuary by heading for the developed nations. They would do this partly because developed nations offer most prospect of support (in principle at least), and partly because these nations could rightly be seen as the principal source of global warming.

All in all, then, national security is no longer about fighting forces and weaponry alone. It relates increasingly to watersheds, croplands, forests, genetic resources, climate and other factors rarely considered by military experts and political leaders, but that taken together deserve to be viewed just as crucial to a nation's security as military prowess. The situation is epitomized by the leader who proclaims he will not permit $1\,m^2$ of national territory to be ceded to a foreign invader, while allowing hundreds of square kilometres of topsoil to be eroded away each year.

All this highlights the need for collective security. Climate change is a problem to which all nations contribute; by which all will be affected; from which no nation can remotely hope to insulate itself; and against which no nation can deploy worthwhile measures on its own. So environmental security lies beyond the scope of established diplomacy and international relations. Indeed it postulates as big a change for the nation-state as any since the emergence of the nation-state system 400 years ago. To cite Sir Crispin Tickell, former British Ambassador to the United Nations, "No man is an island, no island is an island, no continent is an island. Yet nation-states still think principally if not almost entirely in terms of islands – economic, political, environmental islands." To cite too the opening sentence of the Brundtland Commission's report: "Our Earth is one, our world is not."

What can governments do to meet the new challenges? Primarily they can recognise that many forms of environmental impoverishment constitute a distinctive category of international problems, unlike any of the past. They lie beyond the scope of established diplomacy and international relations. While impinging on the strategic interests of individual nations, they prove altogether immune to the standard response to major threats, namely, military force. We cannot launch fighter planes to resist global warming, we cannot despatch tanks to counter advancing deserts, we cannot fire the smartest missiles against rising sea levels.

5. Lack of Predictive Capacity

There is a sizeable difference, moreover, between current analyses and those of the past. The principal point of discourse today lies with the continuing lack of predictive capacity for the ES issue. It is in this respect that the past few years have seen an emergent new "slant" as a growing number of analysts have raised a central critique.

In essence: we still have no over-arching sense of which environmental problems will lead to which sorts of conflict in which lands at which stage of the future. If we knew more along those lines, we could do more to anticipate conflicts and wage pre-emptive strikes (environmental protection measures) against them. Of course the best way to cut off environmental problems at the pass is to tackle them at source. We need much greater effort to push back the deserts, to replant the forests, to get more work out of every unit of energy, to recycle on every side, to stabilize climate, etc. These are all things we should be doing for all kinds of other good reasons, even if there were no security aspect. To this formidable extent, we face a win–win situation.

In short, there is a growing linkage between environment and conflict. Environmental deficiencies supply conditions which render conflict all the more likely. They can serve to determine the source of conflict, they can act as multipliers that aggravate core causes of conflict, and they can help to shape the nature of conflict. Moreover they can not only contribute to conflict, they can stimulate the growing use of force to repress disaffection among those who suffer the consequences of environmental decline.

The meta-problem of Environmental Security began to be recognized in the mid-1980s when the Brundtland Commission included a chapter on the issue in its final report: "The environmental problems of the poor will affect the rich as well in the not too distant future, transmitted through political instability and turmoil." As Mikhail Gorbachev put it in 1989, "The threat from the skies today is not so much nuclear missiles as ozone-layer depletion and global warming." Since the 1980s the issue has steadily grown in importance, and the 1990s, especially the second half, have witnessed an outburst of fresh studies and appraisals (see References and Bibliography, mostly of post-2000 vintage). To this extent, the issue is becoming, shall we say, newer than it has ever been.

In summary review: the ES issue can be defined as the relationship to established security of those environmental factors – water, soil, vegetation, climate, and whatever others are prime components of a nation's environmental foundations – that ultimately underpin all our socioeconomic activities and hence our political stability. Conversely, when these environmental resources are degraded or otherwise depleted, so our security declines too. Thus the definition reflects security in its proper broad sense: security for all, security for ever. However hard it may be to demonstrate the thesis with empirical evidence, it is much harder to demonstrate that the opposite is the case.

6. International Linkages

Certain of the environmental problems cited, notably water shortages, agricultural decline and deforestation, are located almost entirely in developing nations. Why then, one might ask, should security analysts in developed nations be concerned with water disputes in the Indian sub-continent, food shortages in Africa and deforestation in Amazonia? There are several reasons. One arises with respect to political stability in developing countries. To cite a 1988 report of the Ikle and Wohlstetter Commission on Integrated Long-Term Strategy, "Violence in the Third World threatens our interests in a variety of ways. It can imperil a fledgling democracy (as in El Salvador), increase pressures for large-scale migration to the United States (as in Central America), jeopardize important U.S. bases (as in the Philippines), and threaten vital sea lanes (as in the Persian Gulf)." Again, these security linkages between the United States and developing nations apply to other developed nations, albeit with differences in accord with particular strategic relationships.

A second linkage between the developed world and the developing world lies with the fact that environmental problems in one country often spill way beyond its borders. As Amazonia is subjected to widespread burning, roughly one fifth of the world's chief greenhouse gas, carbon dioxide, comes from burning of tropical forests. To this extent, everyone in the developed world has an emphatic interest, whether they are aware of it or not, in what goes on in developing countries way beyond the horizon. Climatic patterns embrace the whole world – and the winds carry no passports.

7. Financial Tradeoffs

The generic question of tradeoffs needs to be addressed in detail with lots of illustrative examples. Suffice it here to note that just 10% of military spending worldwide, now running at well over $3 billion per day, would be enough to finance the Anti-Desertification Plan, to supply clean water and sanitation worldwide, and to upgrade agriculture throughout the developing world. Of the world's $1.2 trillion total military spending, the leaders are the United States with $530 billion per year, the UK with $59 billion, France with $53 billion, China with $50 billion and Japan with $44 billion. In purchasing power parity (PPP) dollar terms China ranks second with $188 billion, India third with $114 billion and Russia fourth with $83 billion (Stockholm International Peace Research Institute (SIPRI), 2007). What is needed urgently is an across-the-board review of the tradeoffs implicit. Data could be obtained from the Earth Policy Institute in Washington DC, SIPRI in Stockholm and the United Nations Development Programme in New York.

8. Conclusion

The field of environmental security gained little attention following its emergence in the mid-1970s. It prompted few substantive assessments until the mid-1990s, whereafter a sizeable number of analysts broached it. Today the field has advanced so far that the overall rationale has been frequently cited among security appraisals by nations such as the United States, the United Kingdom, Norway, India and Australia, also by NATO. Regrettably it has not yet become officially and formally adopted within long-term thinking by any of the nations listed, still less has it become embedded within overall strategic planning. It has a long way to go before it earns the prominence it deserves. All the more welcome, then, is this November 2007 conference.

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POST-CONFLICT ENVIRONMENTAL CHALLENGES

POST-CONFLICT ENVIRONMENTAL HEALTH RISK: THE ROLE OF RISK ANALYSIS IN FOREIGN POLICY

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Abstract: This study examines the valuable role that risk analysis and disaster research can play in redefining national security, particularly for post-conflict construction and development policies. Drawing from environmental risk assessment methodologies, this research highlights how environmental changes before and during conflict can alter risk vulnerabilities, putting particular groups at greater risk and increasing chances for future conflict. Violent conflicts have increasingly affected civilian populations, with armed groups often specifically targeting coping mechanisms and preexisting networks of social relations. Combined with changes to environmental conditions such as contaminants, resource stocks or living conditions, long-term population vulnerability may be created or worsened. Use of landmines, forced migration, destruction of housing and infrastructure, and psycho-social effects of conflict can interact to increase adverse health risks, and it is necessary to identify those groups most at risk and provide suitable policy responses. Case studies from the Balkans will be used to analyze how vulnerable populations are identified in conflict situations, and what lessons this may draw for security and redevelopment policies at the international level.

1. Introduction

The relationship between environment and security has grown increasingly important for policymakers, despite continued difficulties in adequately defining the concept. Environmental security highlights actions that can have severe and negative impacts on the environment, and emphasizes that security can no longer be defined solely in reference to integrity of state borders or institutions. Definitions of security being fluid, policymakers may have difficulty in determining the most appropriate focus when attempting to integrate environmental factors into applied policies. Environmental issues

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tend to exhibit high complexity; they influence many factors but rarely in a linear, causal fashion, and cross boundaries in ways that make reference to any one state difficult. Despite the inherent complexity and uncertainty of environmental issues, it is entirely possible to integrate environmental and ecological factors into foreign policies addressing security and post-conflict reconstruction. Foreign policy and international relations studies can draw from the extensive research of the environmental risk and disaster fields, which with cognate disciplines of geography and public health, can help to identify policy priorities in post-conflict redevelopment issues.

Vulnerability is the most important concept that these fields lends to security, a term with many meanings but one that has been more precisely defined in research methodologies. Conflicts inflict severe impacts upon societies, and a valuable resource will be the ability to identify accurately which groups have been most affected and which are most likely to suffer from future risks. Such risks are not necessarily security related in the traditional context, but rather refer to public health risks that derive from environmental changes and societies' abilities to adapt following a conflict. As conflicts continue to target civilians and damage environments upon which they depend, foreign and security policies should further recognize the crucial links between environmental risk, security, and health.

2. Vulnerability Patterns

Natural disasters and violent conflicts leave lasting developmental effects that may go largely unrecognized, for beyond the terrible toll in dead and wounded, new patterns of vulnerability are created. Such vulnerabilities expose populations to potential events and risks that would not otherwise exist, and may be overlooked if development goals are not carefully prescribed. Environmental and health issues are often paramount in the understanding of vulnerabilities, as they act as media for multivariate processes. Disasters are dynamic processes that put pressure on the ability of individuals and social networks to function normally, depleting various forms of capital that are shared according to preexisting networks in society. Past research strongly suggests that health of communities depends upon stocks of social capital, which are the informal support networks of trust and reciprocity in society. When social capital is highly taxed by exogenous or component factors, society is less able to respond to outside stressors (Lomas, 1998). Environmental events such as floods can act as dynamic processes for those in hazardous situations, imposing higher costs on those most vulnerable and forcing migration of large numbers of people.

Vulnerability can be measured by degrees of resilience and sensitivity, and is often examined at the community or family level. Resilience is the ability of people to return to their former way of life and general standard of living within an acceptable period of time. Communities with high resilience possess coping mechanisms that allow them to rebuild quickly after extreme events, and often rely upon social networks to assist those most severely affected. Sensitivity refers to the extent to which a disaster negatively affects a community. Certain societies have either technological resources or cultural practices that assist them in minimizing effects, while others are at the mercy of particular geographical conditions. Societies that exhibit both high sensitivity and low resilience are most at risk of disasters, and have the most difficulty in returning to a former way of life (Wisner et al., 2005).

The development literature explains vulnerabilities in terms of livelihood models, where vulnerability is measured in terms of the ability of a society/family to maintain its way of life and support mechanisms. Coping mechanisms are used to adapt to changing circumstances, and to provide access to resources under various political, economic and environmental conditions. Rather than being handed down as static properties of a family, one must assume that individuals make decisions based upon opportunities and available resources (Lantze and Raven-Roberts, 2006). If resources can be defined as money, livestock, food, water, transport, or other valuable items, then the (in)ability to achieve those ends depends upon one's coping skills and the support of others in preexisting social networks. This requires ingenuity, local knowledge, and perhaps also actions that are viewed negatively by others, such as drug trading, prostitution, or allegiance to an armed militia. By placing demands upon people's ability to provide for basic needs, disasters often force reactions to changing conditions that may not have been anticipated earlier (LeSage and Majid, 2002).

Disasters also commonly impose adverse health effects on a population. Public health can be reduced (and vulnerability increased) by pollution, poverty, migration and loss of governance, while poor health has a negative feedback effect on economic and social development. Poverty and loss of access to resources often results in poorer health conditions, which can lead to even greater poverty and force residents into other geographic regions as refugees (Lomas, 1998). As social capital is lost in a society, either from migration/death of residents or from loss of livelihoods, it becomes ever more difficult for institutions to assert effective control over a territory. The ability of institutions to provide for basic protection and social welfare may come into question during disasters and conflict, until state functions collapse entirely and a complex emergency occurs. Complex emergencies, often found when natural disasters and conflicts coincide, occur when a state fails completely in its ability to provide security or services for its citizens.

Disasters are therefore more than external events that impact societies. For example, one may understand events after Hurricanes Katrina and Rita in 2005 as not merely natural disasters and the root causes of suffering, but as natural events (dynamic processes) that exposed underlying vulnerabilities in the society – geographically, socioeconomically, racially, and demographically. Thus, in order to understand the impact of disasters or conflict upon society, one cannot simply focus on the event itself, but rather how it differentially affects groups in society (Wisner et al., 2005). In the event of disaster, the most vulnerable groups are those which require the most assistance in recovering, either because they are sensitive to such events or because of lowered resilience. If the resilience of a society is significantly lowered, time horizons shift and people resort to shorter-term thinking in order to ensure day to day survival. The long term sustainability of a society becomes threatened when it is unable to recover from a disaster (Renner and Chafe, 2007).

Lack of sustainability directly translates into environmental terms. For those communities unable to cope with changing conditions, members are more likely to use scarce resources and damage the environment in order to provide what they need. Should they also lack the means to import resources, the disaster may create a negative feedback loop of destructive behaviour undertaken to cope with environmental conditions. Lack of communal resources or access to credit can mean that livelihoods are damaged beyond easy repair, forcing alternative coping mechanisms that are not in the best long-term interests of either individuals or the community. Lasting damage to the ecosystem or the environment can be measured in terms of environmental assessments, but perhaps the best metric for long-term sustainability is to combine knowledge of environmental conditions with measures of public health. Should the health of the community suffer as a result of changing conditions, it may be possible to describe such a process as not merely beginning with a given disaster, but evidence of pre-existing vulnerabilities and altered coping mechanisms with the environment.

For these reasons it is important to note that the effect of environmental scarcity on populations and conflict is not as simple or linear as might be suggested. Past development patterns, especially those modified by conflict or colonialism, may have reduced the resiliency of populations so that they are unable to manage resources in the long-term. Therefore, resiliency may be a more effective factor to measure than simple metrics based upon resource scarcity, as has been relied upon in the past. Scarcity in and of itself may promote cooperation as well as conflict, depending upon political patterns and the effectiveness of governance structures. Disasters and conflicts are not necessarily caused by scarcity or demographics, but rather by underlying patterns of vulnerability that are often the result of political or economic factors.

2.1. RISK ANALYSIS AND CURRENT EFFORTS

The public health community has been concerned about health and vulnerability for many years, especially in researching the health of refugee camp residents during and following conflicts and disasters (Wisner and Adams, 2002). The International Red Cross (ICRC), United Nations Environment Programme (UNEP), and World Health Organization (WHO) have been heavily involved in such efforts, but health consequences of security policies have received far less attention from the social sciences or foreign policy specialists (Guha-Sapir and van Panhuis, 2002). In recent years greater efforts have been made by the Organization for Security and Cooperation in Europe (OSCE) and NATO to provide frameworks for integrating environmental issues into security, aided by organizations such as the Institute for Environmental Security (IES) and the Regional Environmental Center for Central and Eastern Europe (REC). The IES program 'Greening Foreign and Security Policy' consists of four working groups, addressing prediction of instability, prevention of conflict, peacebuilding efforts, and recovery and transition (IES, 2007). The focus on prediction of future conflict is similar to the research on risk and foreign policy developed by David Carment and colleagues in Canada, where environmental issues are considered as factors in political instability (Ampleford et al., 2001). Recovery and transition efforts are the concerns of health and vulnerability studies as described in this paper, and are being developed so that environmental security methodologies will be available to decision-makers in the future.

The need for such efforts stems from the inability of past research or policies to account for environmental health factors in conflict. The connection between security and environmental health has generally been simplified when approached by those in political science, hypothesizing that poor environmental health may lead to interstate conflict (Price-Smith, 2002). Such analyses assume that state capacity falters as infectious diseases become more prevalent, and measure development indices at the macro level. Yet the causal connections in such scenarios are tenuous, at best, and rely upon questionable macroeconomic indicators and an unnecessarily exclusive focus on infectious disease. A focus on traditional environmental measures after violent conflict may also be misleading. By some measures conflict may actually improve long-term environmental conditions (for example, by disabling heavily-polluting industries), but again this is in the aggregate and long-term health may still be negatively affected.

There remains a notable lack of studies on the environmental and health consequences of conflict in the social sciences literature, reflecting the focus on war and conflict as unique political phenomena. Epidemiological studies have shown clear connections between national security policies and health (Levy and Sidel, 2000), and between environmental pollution and health, but too few studies address environmental health consequences of war (Matthew, 2000; Brown, 2004). The role of risk analysis is to illustrate probabilities of harm that may affect a given population, rather than focusing on the state and its institutions. In environment risk assessment the focus often remains at the group or community level, as an aggregation of individuals, or at the ecosystem/biome level. The advantages of such methods are that they allow for more detailed studies of impacts, often human health related that allow for integration with definitions of human security.

The focus on health as a consequence of disasters or violence is not a simple matter, but is crucial for reconstruction efforts (OECD, 1995; Horton, 1999; Van Gennip, 2005). One can only understand public health outcomes when examining in some detail the patterns of vulnerabilities in populations. Epidemiological studies require prior knowledge of how certain groups come to be exposed to certain risks, and resolution of such vulnerabilities similarly requires an understanding of causal links. The manner in which environmental change affects violent conflict or is affected by it, depends largely upon contextual factors and substate processes. The emphasis should remain on the environment as an integral factor, not an external force that creates entirely new conditions. Although health may only be one outcome of the environment-development relationship, it is a key factor to understanding how vulnerabilities shift and influence the course of future development and reconstruction (Harris, 1999).

2.2. CONFLICT AND COMPLEX EMERGENCIES

Disasters and conflict differ in at least one important respect, which is that conflicts do not merely expose vulnerabilities in society, but in fact often target them. Although contrary to the laws of war, it is common for aggressors to specifically target vulnerable civilian populations such as women, children, and the infirm. The progression of the 'total war' concept during the 20th century has decidedly moved away from protection of civilians and their support networks, resulting in ever-increasing civilian casualties and destruction of essential infrastructure. Violent conflicts over the past century have taken an increasing toll on civilians, either directly from combat-related deaths and injuries, or as measured by excess mortality and morbidity during and after a conflict (Weinberg and Simmonds, 1995). Direct deaths during the twentieth century have been estimated at some 216 million, most of them civilians, although this does not count 'structural violence' in countries where people have died due to environmental degradation, disease, famine, and lack of medicine or clean water. Death from structural violence may have reached 18 million per annum by 2000 (Leitenberg, 2006). Environmental health conditions are worsened by movement of troops and refugees, unexploded ordnance (including landmines, cluster munitions and residue from depleted uranium), damage to infrastructure, and contaminant releases from damaged industries.

Many civilian deaths are intentional, even if indirectly. Rather than seeing public health during conflict as an external process, many conflicts directly target the health of vulnerable groups in a population. Public and environmental health rely upon coping mechanisms of civilians and social capital of communities, assets which not only break down during conflicts, but can be exploited as points of vulnerability. In cases of attempted genocide or ethnic cleansing, the intention of many armed groups is to deny another group the ability to rebuild following the conflict. The resiliency of a community is directly targeted, which can involve tactics such as destruction of natural resources, denying access to agricultural land or transportation routes (often using landmines), targeting of medical personnel and facilities, and green infrastructure such as water treatment plants and mass transit. While disaster research and policies assume that the poorest in society are those most vulnerable, such assumptions may mean little in an armed conflict.

Not only are infrastructural and environmental resources targeted during conflicts, but the forced migration of large numbers of people often has detrimental effects on natural resources and the environment. New disease vectors are introduced into populations, especially those suffering from malnutrition, and refugees/IDPs are often forced onto more marginal and less suitable land. New settlements often have fewer environmental resources available, less green infrastructure, and the new built environment often has detrimental public health effects. Health studies of refugee camps have shown pronounced environmental health consequences of such poor conditions, and even resettled communities can exhibit poorer health as a result of poor urban planning, shoddy construction, and lack of access to environmental resources such as potable water (Kalipeni and Oppong, 1998).

The decades-long conflict in Angola exhibited such characteristics. Of the estimated 1.5 million deaths attributable to the war, only some 10–11% were direct battle deaths. A study carried out by the Center for Research on the Epidemiology of Disasters (CRED) in Brussels estimates that excess mortality during the period of the conflict was approximately 70%, but that even years after the conflict had ended excess mortality remained over 40%. IDPs were more at risk than residents who had remained, and children were much more at risk for diarrheal diseases, malaria, and an epidemic of measles that hit the country in 2002. Tuberculosis cases tripled in the immediate post-war years, and more recently cases of cholera have dramatically increased as water sources become ever more contaminated. In total, children have accounted for more than half of all excess deaths, often attributable to lack of sanitation, malnutrition, lack of vaccinations, and overcrowded living conditions among IDPs and refugees (Guha-Sapir and Gomez, 2006). The use of landmines was widespread in Angola, and there remain an estimated 10–20 million landmines throughout the country. UNITA forces deliberately attempted to disrupt daily life and thereby discredit the government, primarily through laying of landmines in agricultural lands, water sources, roads, schools, and villages. Such mine-laying effectively blocked access to much of the country, while imposing a significant direct health risk upon the citizens. Notably, UNITA paid for these landmines through the sale of diamonds (Monin and Gallimore, 2002).

The current situation in Iraq may also be illustrative. Recurring attacks upon infrastructure have left dangerous environmental conditions, such as unattended garbage in city streets, lack of electricity for refrigeration, and contaminated water supplies (UNEP, 2005). Several outbreaks of cholera have been reported by the World Health Organization, an infection that is often a marker of poor sanitation and ability of other diseases to spread easily (WHO, 2007). Physicians and other medical workers have been directly targeted by killings and kidnappings, leaving the country unable to cope with new epidemic infections, while the forced migration of millions has left housing and transport in severe disrepair. Unexploded ordnance and landmines also pose a direct hazard to many, in particular children (Dyer, 2003). The epidemiological studies published in the British medical journal *The Lancet* estimate that excess mortality in Iraq is in the hundreds of thousands since the 2003 invasion, with a substantial portion of such deaths at least partly attributable to worsening environmental and health conditions in the country (Gilbert et al., 2006). Rates of excess morbidity may be a more accurate measure of changing conditions, but it is extremely difficult to conduct such studies when violence is still commonplace (McDonnell, 2004).

Environmental influences on health are crucial for societies, but are often overlooked due to their indirect effects and the difficulty in attributing deliberate action. Post-conflict health policies must be geared toward more than provision of health care, but must also address underlying factors that influence public health and the ability of societies to rebuild effectively following violence. Rather than employing environmental impact assessments (EIA) as technical tools for determining environmental conditions, it may be necessary to apply broader concepts that include historical understandings and political analyses of who the most vulnerable groups are in a given society. Addressing direct exposure to contaminants or provision of healthcare is highly important, but insufficient in ensuring long-term environmental health for a post-conflict region. Providing access to resources and bolstering resilience require determining perceived as well as substantive risks to groups, for such perceptions have very real political and environmental consequences.

2.3. ENVIRONMENTAL JUSTICE AND ATTRIBUTION

Environmental risk assessment recognizes that perceptions of risks can be just as crucial as comparative probabilistic risks. The apparent disjuncture between expert and lay assessment of risks reflects issues of uncertainty, control, media coverage, local knowledge and underlying value judgments concerning safety. Scientific assessments alone are not sufficient to address vulnerable populations, for groups that perceive themselves as vulnerable will act accordingly, irrespective of the technical assessments (Slovic, 1999). Approaches that emphasize merely educating the populace on hazards and risks are insufficient, as they fail to address the political psychology of post-conflict situations and the role that (often outside) researchers may have on the dynamics of such perceptions.

One way of explaining such perceptions is the concept of environmental justice, which has gained popularity in western countries in recent years. Closely related to the study of vulnerable populations and the environment, it posits that certain groups are faced with disproportionate risks from environmental conditions. Environmental justice is an important concept in post-conflict situations, for those living in areas experiencing recurring violence will often explain outcomes vis-à-vis aggressor and victim roles. Lack of access to resources, deteriorating health, and any change in perceived environmental risks will often be blamed on perceived outsiders, perhaps irrespective of the validity of such claims. The roots of violent conflicts can often be traced to attribution toward other groups, where responsibility for undesirable conditions is explained as deliberate action on the part of others (Staub, 1999). As civil conflicts sharpen already existing divisions in society, it is important not to worsen such perceptions by reifying divisions. In a post-conflict situation, the difficulties of identifying vulnerable populations must take note of sensitive political histories and identities, lest health studies be used for entirely political (and often counterproductive) purposes.

Development and rebuilding involve numerous important questions from the perspective of those who have lived through the conflict. Who is forced into certain areas, how is land redistributed, who has access to health care, and who is exposed to certain environmental contaminants? Identification of vulnerable groups is therefore not merely an objective measure of threat, but also a larger political exercise involving justice and risk. In many areas such assessments may run foul of transboundary ethno-linguistic groupings, where environmental conditions experienced by a politically separated group can be used by ‘parent’ nationalism in a bordering state (Dawson, 2000). The strong desire for attribution and explanation for conditions, can lead to calls for restorative or retributive justice on environmental grounds. This is particularly the case when linguistic issues preclude easy translation of terms, as 'justice' and even 'environmental' are not always easily translated with similar meanings and connotations (Briggs, 2005).

Ultimately, researchers must be aware that determination of "vulnerable" status is a political exercise, irrespective of the objectivity of the studies done. To deem a group vulnerable is to justify some measure of outside intervention, as such a group is deemed unable to sustain itself without external aid or guidance. Such designations are likely to be interpreted variously by different groups, and in some cases may worsen the conflict if grievances are directly attributed to outsiders. In such cases, to be objective is not the same as being neutral, and vulnerability risk studies must take political and ethnic divides into account. "To attempt to be 'neutral' in waters already muddled by unavoidable politics is simply to serve the implicit or most powerful political values already present." (Shrader-Frechette, 1985)

3. Environmental Security in Southeastern Europe

Southeastern Europe has exhibited protracted conflict throughout the 1990s, and many regions have yet to recover from the armed conflict. Due to its close proximity to the European Union and NATO countries, the region is of particular interest for redevelopment and reconstruction policies, both of which depend in large part upon meeting European targets for development goals. It may therefore be useful to consider briefly the experience of the region in terms of environmental security and post-conflict health. Despite successful recovery efforts in some countries of the region, states such as Bosnia-Herzegovina or Serbia (Kosovo) remain heavily and negatively influenced by environmental influences of health.

The Balkans region suffered from prolonged conflict during the 1990s, beginning with the Yugoslav civil war in 1991 until the NATO actions in Serbia and Kosovo in 1999. The region of some 25 million people witnessed violent conflict that resulted in an estimated 250,000 deaths (mostly civilians), and millions of refugees and IDPs (Leitenberg, 2006). These countries are coping with the aftereffects of the civil wars and NATO actions, while seeking closer ties to the European Union (EU) and other western organizations. Unlike other former communist states that have achieved membership in the EU, achievement of the *acquis communautaire* will prove much more difficult for those states that have recently experienced conflict. EU membership guidelines, as set out in the Copenhagen Agreements of 1993 & 2002, require certain levels of economic development, environmental quality, and ability to harmonize with EU regulations and directives. For the Balkan states of the former Yugoslavia, attainment of such goals is not merely made problematic by lack of resources.

As documented by UNEP and NATO, direct effects of bombing and heavy artillery destroyed natural resources and in some areas released significant amounts of contaminants into the environment. These include persistent organic pollutants (POPs), heavy metals, and in some areas depleted uranium (DU). Monitoring was established following NATO bombings in 1999, but remediation has been prohibitively expensive, and the continued existence of depleted uranium poses perceived risk issues in Serbia and Kosovo (UNEP, 2002, 2003). Although NATO scientific assessments have indicated that DU poses little risk to local populations, perception of the issue has led many to attribute significant harm from the releases. Residents of Serbia claimed that bombing and use of DU resulted in various illnesses, congenital birth defects, and even introduction of non-native insect species. The UNEP Post-Conflict office carried out an environmental assessment soon after the NATO actions in 1999, but assessments of other areas were made difficult by lack of resources and a breakdown in baseline health statistics (UNEP, 1999, 2004).

Direct actions also largely damaged environmental infrastructure, such as waste or water treatment plants, which themselves had large impacts on the health of populations and quality of the natural environment (De Jong, 2000). In Kosovo conflict disrupted water supplies to much of the countryside, including the regional capital Pristina. UNMIK (United Nations Mission in Kosovo) officials failed to restart water services quickly, a failure for which the ethnic Albanian population blamed Serbs, who traditionally controlled such utilities. Reports of unsanitary conditions for some time afterwards emerged, with the difficulty that United Nations administrators had great difficulty in restoring service and in rural areas had no political control over waterworks (often in areas with Serb majorities). When schoolchildren fell ill for whatever reason, poor water was often cited as the cause, and the other side blamed for deliberate negligence or poisoning. The UNMIK mission could not be judged entirely based upon its stability or ability to maintain order, but was also judged according to its ability to provide services for local populations. UNMIK was judged harshly on other issues as well, such as when the inability to clear rubbish from the streets of Pristina damaged its legitimacy in the eyes of residents (King and Mason, 2006). Many basic environmental institutions suffered from *recreancy*, a condition of delegitimacy in basic institutions entrusted for public health and well-being (Freudenburg, 2003).

The large number of displaced people during the civil wars also created new vulnerabilities, as makeshift settlements in geographically or geologically unsafe regions became permanent, and new/rebuilt settlements lacked careful planning to ensure adequate public health. An outbreak of tulameria, a rodent vectored disease, in Kosovo in 1999–2000 was notable for a condition that would not have appeared in peacetime. Its outbreak among many towns of Kosovo was traced to rural resettlement of displaced people, who lived in conditions of poor sanitation and substandard housing. Other diseases also increased in incidence during and after the conflict, although tulameria was noticed by the WHO due to its uniqueness (Reintjes et al., 2002). In addition to epidemic or endemic diseases, Bosnia-Herzegovina and surrounding areas have witnessed higher infant mortality, higher hospital mortality, and higher rates of non-communicable diseases. Although various factors contribute to the rise of such conditions, the environment is a crucial variable in public health.

Local development in these regions is thus inescapably linked to environmental health conditions, both as poor health impedes development, and as certain patterns of development create new vulnerabilities in society. Lands often cannot be farmed or developed due to the large numbers of landmines sown during the wars. In Bosnia alone some 3–6 million landmines remain in over 16,000 minefields (REC, 2000), and perceptions of risk from depleted uranium change development patterns as local residents attempt to mitigate environmental risks. For those residents who lack the ability to choose their settlement or place of economic activity, they may be exposed to environmental risks that contribute to non-communicable diseases (e.g. cancer, hypothyroidism, neurological damage). Such factors must be added to parallel concerns, such as poor mental health, loss of reliable social networks, loss of support from immediate family members (either displaced or killed), and loss of income.

Future research in this region needs to address the lack of policy-relevant data on public health concerns. Bosnia-Herzegovina (BiH) has very little data available on mortality or morbidity rates, and more than 10 years after the Dayton Accords is unable to direct policies for identifying and assisting vulnerable groups. The lack of data does not reflect a lack of attention on the part of health care professionals, but absent directed and external assistance they have been unable to implement appropriate studies. A lack of coordination between Federation and Republika Srpska regions doubtless worsens the issue, but regional studies are still entirely possible. BiH will continue to focus on redevelopment and reconstruction policies, but should have assessments also carried out on the long-term environmental impact of the war.

In the context of pressures to develop its economy in line with EU accession targets, the real possibility exists that development will proceed without controlling for unintended consequences of economic growth. Bosnia-Herzegovina received large amounts of aid immediately following the cessation of conflict in 1996, often in the form of medical supplies/training, infrastructural aid, and education grants. Yet many of the post-conflict programs were ill-coordinated, short-term, or failed to solve the issues for which they were designed. Even agencies with experience with disaster situations, such as

SIDA or USAID, experienced difficulties in navigating the ethnic tensions and severe politics of the region. Other programs that affect environmental issues should be judged not only for outside measures of sustainability, but also assessed for their impacts on environmental health of affected communities.

4. Conclusion

Considering the difficulties inherent in addressing environmental health for the Balkans, less developed regions may prove even more difficult if one waits for 'suitable' conditions. War-related deaths in Bosnia-Herzegovina occurred largely due to direct trauma, whereas most deaths from civil wars in Africa are attributable to disease, poor sanitation, and other environmental factors (Kunitz, 2004). Guidelines for strategic environmental assessments in post-conflict countries advise waiting until suitable institutions are formed and public participation of stakeholders is possible, yet for many conflict-prone countries this is unlikely to occur. Beginning with small-scale, qualitative epidemiological and risk studies provides a basis for further studies and some potentially useful data for policymakers. Reconstruction efforts should focus on long-term coordination of environmental management and attention to public health, in addition to the institutional and security priorities emphasized by foreign policies.

Both the environmental risk and disaster research areas can make significant contributions to understanding environmental health risks in post-conflict countries. Rather than approaching extreme events as external forces damaging the state, one must examine conflicts in the context of differential risks among vulnerable populations. Failure to address such vulnerabilities may result in a downward spiral of poor public health, increased poverty and loss of governance for affected populations, all necessary factors for reconstruction and redevelopment efforts. The use of violence against the ability of communities to rebuild should be seen as a crucial link to the health and well-being of societies in the post-conflict period, and should increasingly be addressed in the foreign policies of interested and affected states.

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A TREATY FOR A SOUTHEAST EUROPEAN ENERGY COMMUNITY

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Abstract: The Environment and Security Initiative (UNEP/UNDP/OSCE/REC/UNECE and NATO as associate partner), as well as the Regional Environmental Cohesion Initiative as a tool for sustainable development and EU Accession (by NGOs in the region), contribute to moving the Balkan region from conflict towards sustainable development. However, the process is still fragile. The implementation of the Regional Treaty Establishing the Energy Community (ECT) will be an indicator of environmental and energy security.

This paper presents an analysis of the obligations and implementation of the ECT through an environmental security lens. Although the ECT as an international legally binding instrument is contributing to regional development planning, an analysis of the implementation of the ECT reveals serious institutional and capacity gaps. Through this paper the author opens a discussion on effective and harmonized steps towards environmental-energy security (EnEnSEC) and sustainable development in SEE transition countries.

Keywords: Energy security, environmental security, environmental-energy security, Energy Community Treaty, South Eastern Europe, European Union, sustainable development

1. Environmental Security in Practice

Threats to national security include problems with resources and the environment. Environmental security is the term used for issues related to environmental conditions and interests of national security.

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The Environment and Security, or ENVSEC, Initiative (www.envsec.org) was established in 2003 by the United Nations Environment Programme, the United Nations Development Programme, and the Organization for Security and Cooperation in Europe. The North Atlantic Treaty Organization became an associate member of the initiative in 2004, through its Public Diplomacy Division. From 2006, the initiative was strengthened by the joining of two new members: the United Nations Economic Commission for Europe and the Regional Environmental Center for Central and Eastern Europe.

Environmental security is focused on:

(a) Prevention of environment-related conflicts
(b) Satisfaction of the military requirements related to environmental hazards which pose a threat to armed forces and
(c) Remediation of damage to the environment caused by military operations

The South Eastern European region today still represents a geographical gap in the enlarged European Union. Through its activities, the ENVSEC Initiative shows that this geographical gap is accompanied by environmental problems which threaten or are perceived to threaten security (Mihajlov, 2001, 2004b), societal stability, peace, human health and/or sustainable livelihoods (Mihajlov, 2007b) within and across national borders in this conflict-prone region.

In addition, from the perspective of climate change adaptation, the SEE region is among the most sensitive regions in Europe. One of the most important challenges in SEE is to address the inefficient use of energy (EBRD Transition Report, 2006).

2. SEE Regional Energy Community Treaty

The European Community and the contracting Parties to the ECT decided in October 2005 to create an Energy Community (www.energy-community.org). The Contracting Parties are: the Republic of Albania, the Republic of Bulgaria, Bosnia and Herzegovina, the Republic of Croatia, the former Yugoslav Republic of Macedonia, the Republic of Montenegro, Romania, the Republic of Serbia and The United Nations Interim Administration Mission in Kosovo pursuant to United Nations Security Council Resolution 1244.

The ECT imposes obligations on the Parties to adopt a series of measures that will help them manage their energy systems more effectively. The activities of the Energy Community include, among others, the implementation of the *acquis communautaire* on:

– Energy
– Environment
– Competition and
– Renewables

According to the ECT, after its entry into force (which took place in October 2006), among other obligations, the construction and operation of new generating plants (in relation with Network Energy – the electricity and gas sectors) shall comply with *the acquis communautaire on environment*. Furthermore the contracting Parties recognize the importance of the Kyoto Protocol and agree that they shall endeavor to accede to it. The Treaty supports the SEE countries' approximation of the technical, legislative and other important standards of the EU. In particular:

– The ECT represents a strong commitment by Parties towards market-oriented reforms, regional integration and sustainable development.
– It constitutes a legally binding legal framework for an integrated energy market (as such it extends the EU internal market for energy to the Balkans).
– It is an agreed policy framework for infrastructure investments including the expansion of the natural gas distribution system to create an intermediate gas market between the Caspian Sea and the EU.

Implied in the Treaty is the adoption of certain legal norms of the EU related to energy including renewable energy, environmental protection, and competition (see Annex II of the Treaty, as well as Human Development Report, UNDP, 2004, 2007; Kovacevic et al., 2007; Mihajlov, 2006; Stritih et al., 2007).

What does this really mean?

The timetable for the implementation of the environmental *acquis* is as follows:

(a) As of the date of entry into force of this Treaty (*October 2006*), each Contracting Party will implement:
   – The "EIA Directive," i.e., Council Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment, as amended by Council Directives 97/11/EC of 3 March 1997 and Directive 2003/35/EC of the European Parliament and of the Council of 26 May 2003.
   – Article 4(2) of Directive 79/409/EEC of the Council of 2 April 1979 on the conservation of wild birds.

(b) *By 31 December 2011*, each Contracting Party shall implement Council Directive 1999/32/EC of 26 April 1999 relating to a reduction in the sulphur content of certain liquid fuels and amending Directive 93/12/EEC.
(c) *By 31 December 2017*, each Contracting Party shall implement Directive 2001/80/EC of the European Parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants.

Although the years 2011 and 2017 are not far off when talking of technical preconditions to assure obligations have been met (reduction in the sulphur content of certain liquid fuels and the limitation of emissions of certain pollutants into the air from large combustion plants), in this paper I am focusing on EU Directives that have already been approximated in all the Western Balkan countries.

The EIA Directive is one of the major horizontal directives (http://europa.eu.int/eur-lex/index.html). Within the process of harmonization with this Directive, it is necessary to adapt the regimen of approval of impact assessments with the list of projects and procedures in the manner regulated by the Directive. The purpose of environmental impact assessment is for predicting, characterizing and quantifying the possible consequences (impacts) on the environment, of any project (activity) while still in the planning stage.

The EIA Directive lists 35 types of activities for which it is necessary to perform an environmental impact assessment. The EIA Study contains a description of the object or activities, a description of the current state of the environment (at the concrete location or within the entire area that might be affected), and a description and quantification of the magnitude and significance of the potential direct, indirect, cumulative and long-term impacts on the environment during normal operations and as the result of potential accidents.

The "Birds Directive" (Council Directive 79/409/EEC on the conservation of wild birds) aims at the protection of all wild bird species within EU territory. Member States are obliged to establish a general system of protection for their naturally occurring wild bird populations which are declining in numbers on European territory. Through sound policies, the member states should take such measures as will alleviate the repercussions of human activities and in particular the destruction and pollution of wild bird habitats, as well as the capturing, killing and trading resulting from such practices. Member countries should maintain or restore biotopes and create protected areas in order to preserve current population levels of wild birds. The most suitable areas for the protection of wild bird species have been labeled as "areas under special protection". Member states are obliged to provide protection of those areas from pollution or damage.

As shown in the scheme below, energy price depends on Energy and Environmental Security.

The above analysis gives grounds to introduce and propose in this paper a new term: environmental-energy security (EnEnSEC).

In addition, the ECT recognizes the importance of the Kyoto Protocol and obliges the Parties to endeavor to accede to it. The Kyoto Protocol entered into force in February 2005. It created three flexible mechanisms with the aim of assisting developed countries (Annex I Members) to decrease their costs of attaining greenhouse gas (GHG) emission reduction targets (first between 2008 and 2012) by decreasing emissions in other countries where such costs are smaller.

Additionally, it should be pointed out that the Energy Community has long recognized the need to further *promote renewable energy* given that its exploitation contributes to climate change mitigation through the reduction of GHG emissions, sustainable development, security of supply and the development of a knowledge-based industry creating jobs, economic growth, competitiveness and regional and rural development.

The ECT does not refer specifically to the coal industry. Its implementation will have major impacts on this sector.

The contribution of renewable energy to energy security is not widely recognized – for countries where growing dependence on imported gas is a significant energy security issue, renewables can provide alternatives (Mihajlov et al., 2007a).

Although the ECT as an international legally binding instrument is contributing to regional development planning, an analysis of the implementation of the ECT reveals serious gaps in the institutional capacities of each Contracting Party in the SEE region.

In addition, current EIA practice in SEE countries does not show recognition of how the application of the EIA Directive establishes strong partnerships between decision makers and stakeholders. This is true even in the countries where the Directive has been transposed into national legislation, but where nevertheless there are serious problems in implementation).

3. Concluding Remarks: The Process Is Still Fragile

The stabilization of the energy sector (addressed together with environmental requirements and concerns) will assist the macro-economic regeneration of the region, contribute to peace, economic growth and development (sustainable development), decrease emigration rates, and decrease poverty.

South-Eastern Europe should be a strategic partner in EU energy policy.

The ENVSEC Initiative, as well as the Regional Environmental Cohesion Initiative as a tool for sustainable development and EU Accession (established by NGOs in the region, see www.ambassadors-env.org, Mihajlov, 2004a) contribute to moving the Balkan region from conflict towards sustainable development (Mihajlov, 2001).

Some priorities for action (for both electricity and gas networks) could be listed (PIP, 2007), in order to make the system less fragile than it is now:

- Putting into place equipment or installations essential for the system in question to operate properly, including protection, monitoring and control systems
- Adapting and developing networks to facilitate the integration and connection of renewable energy production

Energy policy goals cannot be reached without seriously addressing environmental concerns (as related to the ECT – in the power sector and for SEE gasification – this means compliance with EU environmental standards) and applying EnEnSec measures.

Implementation of the Regional Treaty Establishing the Energy Community will be an indicator of environmental and energy security.

As a follow-up to the present framework analysis of the obligations and implementation of the ECT through an environmental security lens, a more detailed analysis by a multi-stakeholder coalition could be important in order to make the process less fragile and to ensure the region's environmental and energy security.

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NATURAL RESOURCES MANAGEMENT IN THE ABSENCE OF THE RULE OF LAW: A CASE STUDY FROM BOSNIA AND HERZEGOVINA

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Abstract: During the civil war in Bosnia and Herzegovina, an estimated 100,000 were killed, homes and businesses were destroyed, and the legal system was rendered obsolete. Since the war ended in 1995, a new legal system has been under construction. Sweeping changes were necessary to address ramifications of the war and to shift from a socialist to a capitalist society. The development of environmental laws has not been a priority. The new governmental structure sets competency over natural resources – not at the national level, but at fragmented lower levels of government, frustrating effective forest management. Half of the country is forested. Timber is its most valuable resource, providing its most significant exports. Initially, individuals with few alternatives harvested firewood. Subsistence harvesting evolved into large scale resource plunder. Organized crime is involved in illegal logging, reinforcing paths used for trafficking people, drugs and weapons. Pervasive corruption in forestry management discourages international investment. The weak state of the law not only allows environmental degradation, it destabilizes this fragile country and impedes post-war recovery.

1. Introduction

This paper examines the management of Bosnia and Herzegovina's ("BiH") forests and explores challenges to resource sustainability and environmental protection. It is designed as a short case study to facilitate review of similar issues in other post-conflict countries.

The first section presents an overview of the forest resource and its value to the economic recovery of BiH. The next section examines changes that arose as a result of the conflict. The third section discusses forest management in post-conflict BiH. The final section outlines the environmental, economic and security consequences of failure to effectively manage this resource.

S. Stec and B. Baraj (eds.), Energy and Environmental Challenges to Security,

The war lasted from 1992 through 1995 in BiH. During the conflict, an estimated 100,000 were killed, homes and businesses were destroyed and the legal system that had been in place was rendered obsolete. After the Dayton Peace Agreement was signed in December 1995, there were still countless missing, the economy was in shambles and a functioning legal system was needed.

Since 1995, BiH's legal system has been under construction. Sweeping changes were necessary to address ramifications of the war and to shift from a socialist to a capitalist society. Neither the international community nor the new government has considered environmental laws a priority. Additionally, the new governmental structure sets competency over natural resources – not at the national level, but at fragmented lower levels of government. Consequently, there has been little effective regulation of the nation's forests. Government managers of the forest resource have been unable to curtail illegal logging, deforestation and environmental degradation. The fragmented management structure allows corruption and prevents sustainable resource management. Twelve years after the conflict, BiH has yet to develop a national forestry plan.

Timber is BiH's most valuable resource; wood and wood products are its most significant exports. International aid organizations have identified the forestry sector as one of the most promising areas for foreign investment. However, effective regulation and a comprehensive forestry plan are necessary to restore the sector as an engine of legitimate economic growth.

In the absence of coherent regulation and policy development, the resource is being plundered. Proceeds of the sale of illegally harvested timber are being used to finance organized criminal networks and destabilizing activities.

2. The Resource

BiH is located in south-eastern Europe, sharing borders with Croatia, Serbia and Montenegro. It measures 51,129 km^2. Fifty percent of the country is characterized as forest land and 43% is under forest cover. The following tree species predominate: Beech, Oak, Fir, Spruce, Black Pine, Scots Pine, Maple, Cherry and Walnut. The World Bank reports that the variety of species and extent of the resource relative to the size of the country make BiH's forests the richest in Europe (World Bank, 2003b).

The terrain of BiH varies considerably, from high mountains (maximum altitude of 2,386 m on Mt. Maglic) to sea-level on the Adriatic coast (at Neum). Precipitation varies across the country from 800 to 2,000 mm/year. Average annual precipitation is 904 mm (United Nations Food and Agriculture Country Reports: BiH, 2006). The high rate of precipitation combined with steep terrain make erosion a serious concern in some parts of the country (RS Ministry of Agriculture, Forestry and Water Management, 2007).

Eighty percent of BiH's forest land is publicly-owned. The remaining privately owned forest lands are predominately small parcels of, on average, 2 acres.[1] Ninety-four percent of all forest land is classified by governmental authorities for timber production (Dennison, 2006). Less than half of 1% of BiH's forest land is protected from timber harvesting as national parks (ibid.).

Timber is sold raw, milled and converted into pulp. BiH exports both wood and wood products. Exports include whole logs, plywood boards, veneer, joinery and furniture (Dennison, 2006).

Analysis of the economic value of the forestry sector has been conducted by USAID (Dennison, 2006). In 2003, the forestry sector's direct contribution to the national GDP was 888 million KM (konvertibilna mark, the unit of currency in Bosnia Herzegovina) and direct benefit obtained from export trade in forestry products was 660 million KM. During the period 2001–2003, wood and wood based products were the country's most important exports, accounting for 21% of total exports. Last year, wood exports totaled 775 million KM. The forestry sector is currently the only sector in the BiH economy with a positive export to import ratio – three times the amount of wood and wood products are exported (BiH Foreign Trade Chamber, 2008).

A relatively new phenomenon is growth in the harvest and marketing of non-timber organic material from the forest, such as wild aromatic plants, mushrooms, seeds and berries. The commercial market for these organic materials has been growing steadily worldwide. USAID found that 60% of BiH's rural families make 70% or more of their household income through the collection of non-timber forest products (Dennison, 2006).

Non-timber forest products are usually exported abroad. Most of the forest products collected in BiH are sold in Italy, Germany and Slovenia (ibid.).

Despite the potential impact on the nation's forests, at the time of writing, the harvesting of non-timber forest products is unregulated except in specially protected areas (i.e. national parks) (see Federation Law on Nature Protection and RS Law on Nature Protection). This regulatory gap fosters deleterious and unsustainable harvesting practices.

Additionally, some of the species currently collected in BiH's publicly held forests are endangered. Endangered species are protected by international law. Since BiH is a party to CITES (Convention on International Trade in Endangered Species of Wild Flora and Fauna), its failure to establish a mechanism to protect listed species and to track their trade constitutes a breach of international commitments. Neglect of these obligations could lead to eradication of some plant species from the region.

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[1] As the vast majority of forest lands are publicly held, this paper focuses on management of these forests. Privatization of BiH's publicly held forests is in the initial stages. The privatization process is likely to present its own challenges, however these are outside the scope of this paper.

3. Changes Arising from the Conflict

3.1. POPULATION SHIFTS

The prewar population for the area that is now BiH was 4.4 million (Agency for Statistics of BiH, 2005). During the war, an estimated 100,000 were killed, an additional number are still classified as missing persons (Research and Documentation Center, 2007). There was also considerable movement of refugees to new locations and from rural communities to urban centers. As a result of the conflict, approximately 1.8 million people were displaced (UNHCR, 2007).

In the immediate post-war period, the international community devoted significant resources to ensuring the right to return of refugees and displaced persons to their pre-war homes. At this point, the return process is considered almost complete (ibid.). However, the return figures are far from reflecting population shifts that occurred as a result of the conflict.

In many cases, displaced families had established themselves elsewhere or did not feel comfortable returning to pre-war communities. Older people, with no alternatives, were often the only ones to physically return. Educated or qualified people followed opportunities elsewhere, legally reclaiming their property, but not physically returning to their pre-war communities.

Before the war, 1.7 million people, 60% of the population, lived in rural communities (Agency for Statistics of BiH, 2005). Now, most of the population lives in urban centers while only about 40% lives in rural communities – the opposite of the pre-war situation (World Bank, 2008).[2]

Urban centers are overburdened as population changes occurred without corresponding infrastructure changes or city planning. Poverty, especially in rural areas, has also increased which has led to increased exploitation of public forests.

3.2. INCREASED FUELWOOD CONSUMPTION

During the war, commercial timber harvesting from public lands stopped completely. However, the amount of wood gathered by individuals for household heating and cooking increased. Breakdowns in the supply of natural gas and electricity during the war forced people to burn wood for fuel. Irregularities in distribution of natural gas continued after the conflict causing many communities to continue to rely on wood for heating.

[2] A census has not been taken since 1991, but the current population of BiH is estimated at 3.9 million.

Increased poverty means that fuelwood is still being collected from publicly owned forests in large quantities. Up to 80% of rural people depend on fuelwood as their principle source of energy (Saylor, 2005). Many urban dwellers also now heat with wood. Thus, markets for firewood are encouraged in cities, such as Sarajevo and Tuzla, further stressing the resource. People simply cannot afford alternative means of home heating (Office of the BiH Coordinator for Poverty Reduction Strategy Paper, 2004). At the time of writing, in Sarajevo, half of the average monthly salary is spent on heating.

Many forest lands in BiH are practicably inaccessible because (1) there are no intersecting roads, (2) the terrain is too steep, and/or (3) they are contaminated by landmines. Consequently, fuelwood, including logs, brush and branches, is overwhelmingly gathered from forest edges. The more accessible areas of the forests are thus heavily overexploited. The loss of immature trees and undergrowth that would ordinarily provide nutrients to the soil impacts forests' long-term ability to regenerate (BiH NEAP Directorate, 2003).

Collection of fuelwood by private individuals is largely unregulated. There is no real government oversight (monitoring, quantifying, or reporting) of this significant impact on the resource.

3.3. LANDSCAPE CHANGES

The First National Report on the Implementation of the United Nations Convention to Combat Desertification/Land Degradation in BiH was issued in February 2007. This report finds that tank movement, trench digging, and tree clearing and burning for strategic purposes had a direct and lasting impact on the forests of BiH. Impacted areas show irreversible soil nutrient loss and erosion.

A large number of landmines were also planted during the war. The Mine Action Center (the international agency charged with mine removal in BiH) estimates that 10% of the country is still contaminated by landmines.

Since landmines were usually placed near roads, their presence reduces the amount of forest accessible from vehicles for any purpose (e.g. commercial harvesting, maintenance, fuelwood collection). Development projects estimate that only half of the publicly owned forests are currently accessible for commercial harvesting – a significant difference from the 94% classified for timber production (Dennison, 2006).

The inaccessibility of much of the forest lands also makes it difficult to effectively control insect infestations and forest fires. Reports concerning control of Bark Beetle infestation illustrate the difficulty inherent in addressing problems in mined forests (see World Bank, 2003a). There was a serious infestation of Bark Beetle in BiH's spruce forests after the war. Efforts to control it were ultimately successful, but the front line areas were considerably more time consuming, costly and problematic to treat.

3.4. INDUSTRY CHANGES

Damage to the wood processing industry as a result of the conflict is estimated at €2 billion (Hadziabdic, 2004). This figure includes equipment and infrastructure damage, loss of producing forests and personnel.

Before the war, 200 production enterprises existed and exports of value added wood products (e.g. furniture) were estimated at €350 million (UNCTAD Advisory Services on Investment and Training, 2004). Now, BiH's industry is largely composed of smaller, unregulated[3] sawmills. These facilities are only capable of the most rudimentary wood processing (Dennison, 2006). Most of the revenue that has been produced by the forestry sector since the war is the result of the sale of raw timber, not value added products. This means an enormous loss of potential as the country is denied jobs and business opportunities that would be created in the manufacturing of value added goods.[4]

During the conflict and period of reconstruction, BiH lost its industry export market share. Commercial wood processing stopped completely during the war. Since 1992, companies abroad have found new sources and structured alternative agreements for wood and wood products.

To further compound these losses, over the last decade, the global wood processing industry has changed. More skilled and differently trained workers are now required. However, BiH's vocational students are not receiving relevant modern education to adjust to the new wood processing industry (Hadziabdic, 2004). The technology and equipment that survived the war are also hopelessly outdated (Dennison, 2006).

3.5. OVERHAUL OF THE LEGAL SYSTEM

The partitioning of the former Yugoslavia and the creation of BiH rendered much of the legal system that had been in place obsolete. Sweeping changes were necessary to incorporate democratic principles and to address ramifications of the war. The criminal procedure code was rewritten and a new tribunal was established to tackle war crimes and human rights violations. The civil

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[3] After the conflict, innumerable small unlicensed sawmills sprang up across the country. A quantity of these are disappearing, but many poorly regulated sawmills remain.

[4] International development projects report that new investors are entering the market and beginning to produce value added products. Export growth rate for these products has recently begun to grow.

and property law systems also underwent substantial changes. Every aspect of the legal system was modified in some way.

Under the laws of the former Yugoslavia, forest management in BiH was organized into forest management regions. These regions were divided into 50 management units under the stewardship of two large companies. These companies oversaw 99% of the forest land in the territory that is now BiH (Hadziabdic, 2004).

The Dayton Peace Agreement divided the country into two distinct political and administrative Entities, the Republika Srpska and the Federation BiH.[5] The old forest management units were collapsed into the new governmental structure. Republika Srpska now has 14 of the original units; the Federation has 9, and 27 straddle Entity lines (ibid.).

Forest management areas have been reconfigured to fit Entity boundaries. As the Entity lines were drawn to reflect political rather than natural considerations, forest management areas are no longer based on physical characteristics (i.e. watercourses, terrain, species groupings).

4. Forest Management in Post-conflict BiH

4.1. GOVERNMENTAL STRUCTURE

The Dayton Peace Agreement, signed on December 14, 1995, provides the foundation of BiH and is the basis for its State (i.e. national) constitution. It establishes a State composed of two Entities and the Brcko District.

Each of the Entities, the Republika Srpska and the Federation, and the Brcko District has its own constitution and government. Very few things are managed at the state level. Under the constitutional order, the entities have competency over environmental matters and natural resource management.

The Republika Srpska is managed as a single unit while the Federation is further divided into ten Cantons. The Federation Constitution devolves most competencies to the Cantonal governments. Each Canton has its own government and constitution. Each Canton has competency over the natural resources within its political boundaries.

Each of these levels of government has legislative responsibilities. Thus, an issue will be regulated at the Cantonal level, Entity level and State level. Harmonization of legislation is required, but is often time consuming and/or politically difficult to achieve.

[5] The Peace Agreement also created the Brcko District which is not discussed here as it does not contain any forest management units. The governmental structure is discussed more fully below.

The Dayton Peace Agreement also established the "Office of the High Representative" to oversee implementation of the civilian aspects of the peace process in BiH. The High Representative is appointed by the United Nations. Since 1995, there have been six High Representatives from six European Nations. The High Representative has sweeping powers to oversee the government of BiH, impose legislation, and fire officials.

The Office of the High Representative is designed to be phased out as BiH stabilizes. The last High Representative was to have transferred his powers in 2008 as part of the planned phase-out. However, the United Nations Peace Implementation Council recently extended the mandate of the Office of High Representative because it is dissatisfied with BiH's progress towards implementation of the peace agreement (Peace Implementation Council Steering Board, 2007).

4.2. MANAGEMENT OF PUBLIC FORESTS

Under the Consitution the State government has the authority to bind BiH to international treaties, including those relevant to the forestry sector. Apart from this responsibility, there is no state-level oversight of forestry management. There is no state-level forestry legislation and no national policy regarding management of public forests.

Responsibility for administration of publicly-owned forests for commercial production falls to the Entities. In the Federation it lies with the Ministry of Agriculture, Water Management and Forestry. In the Republika Srpska, it lies with the Ministry of Agriculture, Forestry and Water Resources.[6]

Both Entities have adopted a Law on Forests. These laws establish the legal basis for regulation of public forests at Entity-level. The Entities' laws establish (1) administrative institutions (2) general rights and obligations and (3) procedures for permitting and restricting forest activities (Federation Law on Forests and RS Law on Forests).

The Federation law envisages management of forests for timber production in coordination with other environmental uses such as erosion control, water quality protection and recreation. The RS law focuses exclusively on management of forests for production.

Under the Federation Law on Forests, each Canton has competency over the forests within its jurisdiction. Each Canton must designate a public company responsible for the management of its forests. This requirement has not been fully implemented. USAID reports that not all of the forest

[6] Responsibility over protected forest lands lies with the Federation's Ministry of Regional Planning and Environment and the RS Ministry of Science, Technology and Culture. Note that this is less than half of 1% of all forest lands.

management companies have been established and some forest management companies have been created but are not functioning (Dennison, 2006).

As Cantonal borders are the result of political not natural considerations, this structure, even if fully operational, does not lend itself to rational resource management.

Failure by the Cantonal governments to properly regulate forests perpetuates misuse of the resource. For example, in some areas of the Federation, hardwood stands are being clear cut and processed into low grade charcoal rather than sustainably harvested for furniture production.[7]

In contrast, in the Republika Srpska, one enterprise, Srpske Suma, has management responsibility over all public forest land and has the potential to provide a more unified approach to resource management.

Unfortunately, in the past, weaknesses in the Republika Srpska law establishing the enterprise allowed corruption on a massive scale (RS Law on Enterprises).[8] The enterprise was so mired in corruption that in 2004, the High Representative fired the entire top level management of Srpske Suma (OHR, 2004). At the time of writing, 13 people, including the former Prime Minister of the Republika Srpska, have been charged with crimes associated with management of Srpske Suma (Bosnia Daily, 2007a).[9]

In the Republika Srpska, forest administration is funded through the Entity budget. In the Federation, Cantonal Forest Management Companies are primarily financed by their own revenues (Dennison, 2006). When the Cantonal Forest Management Companies are fully functional, this financing mechanism has the potential to force felling without regard to other long-term forest benefits, such as erosion control.

Timber is not currently sold through a transparent and competitive process. Concessions are awarded and prices are set by Cantonal and Entity Forest Management Companies (USAID CCA, 2006). Competition for survival among sawmills is fierce. As the demand for timber exceeds the available annual allowable cut by a factor of three, this process has only encouraged bribery. Foreign investment and desirable enterprises (i.e. wood processors creating value added products) have been lost because of local authorities' inability to guarantee them sufficient timber through this process (ibid.).

BiH's forest management structure is burdensome and ill suited to protect the environment or resource sustainability. However, at this juncture, no

[7] Field notes of an international development worker.

[8] The RS Law on Enterprises was amended in 2006.

[9] In no way is corruption in this sector limited to the RS. The manager of Sume Herceg-Bosne was also fired by the High Representative. In that case, however, the High Representative removed only this one individual from office (OHR, 2002).

change is possible. Politically charged constitutional changes are necessary to reallocate competencies over resource management.

4.3. LACK OF COMPREHENSIVE POLICY DEVELOPMENT

Because of BiH's fragmented governmental structure, the absence of a national level policy for forest management is disastrous. As the division of forest lands is on political rather than natural lines, it is critical that policy be developed that allows cross-cantonal and cross-entity management.

Recent fires in the south illustrate the desperate need for a more comprehensive approach to forest management. Local authorities were unable to effectively coordinate efforts to fight the fires that spread from Dubrovnik to Mostar this summer. There was a tremendous amount of disagreement over jurisdiction and blame-shifting, but at base the problem lay in local authorities' inability to share their limited resources (information, equipment, personnel).

The absence of a national policy also leaves BiH floundering in isolation when many other European nations are working collaboratively to address forestry issues. Again drawing on the example provided by this summer's fires, despite general emergency response agreements, BiH and Croatia were unable to work together to fight these fires. A detailed national policy regarding cross-border forest fires might have averted some of the delays and inflammatory rhetoric (see Bosnia Daily, 2007b).

Several international processes are available which could help BiH manage its forest resource with better assistance from regional partners (e.g. Ministerial Forest Process, Forest Law Enforcement and Governance processes), but these require planning and commitments on the national level.

The development of the timber resource for economic recovery would also benefit from state-level planning and coordination. Planning regarding industry capacity, technical training, and market development would be considerably more efficient at the national level.

On a positive note, there seems to be political will to develop more comprehensive forestry policy. An inter-Entity body is in the process of being established to coordinate forestry policy. At the time of writing, governing legislation for this body is being drafted. Hopefully, this coordination body will have concrete responsibilities to develop a coherent national forestry plan.

5. Consequences of Ineffective Management

5.1. ILLEGAL LOGGING AND CORRUPTION

Ineffective management of the forest resource directly affects the government's ability to combat illegal logging and corruption.

Illegal logging is narrowly defined by BiH government authorities as involving unauthorized harvesting, noncompliance with cutting regulations and outright theft (Saylor, 2005). This characterization necessarily focuses law enforcement on the activities of third parties – parties outside of government or resource management.

Illegal logging is perpetrated by both rural residents collecting fuelwood to meet basic needs and organized criminal networks transporting whole logs across borders to profit from higher prices offered for hardwoods in Serbia and Italy. Illegal logging, so defined, is estimated at a value of more than $20 million per year (Saylor, 2005).

Notably, corruption in the forestry sector is not encompassed in this definition of "illegal logging". However, corruption is endemic to almost every aspect of BiH government and society, including forest management. Transparency International's annual corruption index ranked BiH 93rd for 2006, among the most corrupt nations in the world. The extent of corruption in the forestry sector is difficult to determine with certainty, but it is presumed that a significant portion of the income produced by the sector goes into the black market. Transparency International found that the most frequent citizen complaints received by its Legal and Advocacy Center involved corruption in three public companies – two of which are forest management companies (Transparency International, 2004).

BBC News reports that the Bosnian economy loses an estimated $100 million per year through tax evasion and corruption in the forestry industry (Hawton, 2005).

> The industry is riddled with corruption, from the lowest worker to the levels of top management. It even reaches political circles, where profits from the industry are used to pay off political favors' says one international investigator, who asked not to be named (ibid.).

It is widely believed that funds funneled from the forestry sector are used to support indicted war criminals. EUFOR, the European Union Peacekeeping Force charged with implementing the Dayton Peace Agreement, has begun to pursue illegal logging operators because of local government's inability to tackle the problem and the security risk posed by the continued presence of these fugitives in the country (United Nations Security Council Report, 2006). The use of EUFOR resources (e.g. helicopters for surveillance and troops for random road checks) to combat illegal logging is, at best, a temporary solution. Relying on the international community for this policing function, BiH has not developed its own capacity in the area. The international community will eventually withdraw from BiH and local authorities must find a way to both fund and coordinate law enforcement over the longer term.

Lack of control over BiH's most precious resource attracts organized criminal movement into the sector. Forest crimes are not simply profitable, they are perceived as risk-free. Further, networks strengthened by and for illegal logging reinforce paths used for trafficking people, drugs, and weapons.

It is sobering to consider the lost opportunities that follow. Revenue from the timber industry is desperately needed to rebuild the country, foreign investment in this sector is contingent on a functioning regulatory environment and depletion of the resource by destructive cutting practices will have a lasting impact on future generations.

5.2. ENVIRONMENTAL DEGRADATION

The unwieldy resource management structure and lack of enforcement has led to considerable environmental degradation since the conflict. For instance, clear cutting and controlled burning[10] that have been undertaken over the last decade are now anticipated to have long-term consequences for BiH's forest lands and their associated environmental uses (e.g. erosion control, water quality protection) (RS Ministry of Agriculture, Forestry and Water Management, 2007). Also, roads and buildings have been constructed with little effort to minimize environmental impact, leading to erosion and top soil loss. The timber industry and illegal logging have begun, in the last few years, to negatively affect water quality (ibid.).

Yet, long term plans for BiH depend upon a healthy environment. Considerable resources have been invested into the development of ecotourism and enterprises relying on clean water, such as organic produce and fish farming. BiH's greatest economic potential and possible contribution to the European Union rest in its natural assets.

In the National Environmental Action Plan, increasing poverty is identified as a major contributor to environmental degradation in BiH (BiH NEAP Directorate, 2003). In 2003, two thirds of the population was reported to be living at subsistence level or lower (ibid.). The economy has not significantly improved. The current per capita GNI of BiH is US$2,980 (World Bank, 2008). Unemployment is presently over 45% (CIA World Factbook, 2007).[11] Poverty is driving environmentally destructive activities such as unsustainable harvesting of firewood and eradication of protected species.

Deteriorating soil and water quality, desperation and lawlessness combine to destabilize a fragile post-conflict BiH.

[10] This practice is most often used to increase pasture areas.

[11] Unemployment statistics for BiH are difficult to accurately capture. According to the CIA World Factbook, BiH's "grey economy" could be as much as 50% of official GDP.

6. Conclusion

This paper is meant to provide a brief overview of current challenges to effective forest management in BiH.

All of the changes arising from the conflict in BiH: (1) population shifts, (2) increased poverty negatively impacting resources, (3) landscape changes, (4) industry changes and (5) a new legal or management system that is disconnected from biophysical realities, can be easily imagined in other post-conflict countries. BiH makes an interesting case study because consequences of failure to address issues presented by these changes are not theoretical. The consequences of a deficient regulatory system for forest resource management are already visible.

Illegal logging results in a loss of at least \$120 million per year to the national economy. This direct loss pales in comparison to the lost opportunities to improve living conditions in BiH. Environmentally degrading practices begun during the conflict have continued unregulated in the post-conflict period. Poverty, coupled with hopelessness for the future, threatens security in post-conflict BiH.

Timber is one of BiH's most valuable assets. Effective oversight is critical to avoid both depletion of the resource and misuse of proceeds from its sale. In post-conflict BiH, the absence of an effective or even functioning management system allows forest resources to be diverted from legitimate economic recovery activities to destabilizing ones.

In a post-conflict country, can management of its most important natural resources be neglected without serious environmental, economic and security consequences?

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KOSOVO – ENERGY AND ENVIRONMENTAL CHALLENGES TO SECURITY

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Abstract: The environmental status of Kosovo is dominated by a range of issues including polluted soil and water and poor infrastructure management generated mostly by the lack of an environmental protection regime in the past. Based on the research and measurements carried out up to now and also through site visits, information gathering and empiric comparison with the results of previous activities in the sector, it is obvious that environmental pollution in Kosovo is relatively high, caused from different sources such as: energy production facilities (TPP), industrial facilities (metallurgy factories, quarrying sites and cement factories), the transport sector, activities in agriculture, industrial and urban waste, central and individual heating, low quality infrastructure, etc. The Kosovo Energy Strategy and Kosovo Development Strategy and Action Plan, through the Environmental Strategy of Kosovo, recognize the opportunities for improving environmental goals through:

- Reducing environmental impacts of energy use and promoting environmental awareness in the operation of the energy industry.
- Maintaining the increase of energy efficiency, the increase and improvement of energy savings, and the use of economic, regulatory and legal instruments for energy efficiency and savings.
- Implementing appropriate transportation policies.

1. Introduction

Kosovo is a small territory in the center of the Balkan Peninsula. Kosovo covers a surface land area of 10.887 km^2. The total population is not known; however based on previous data and present evaluations, it is estimated that Kosovo has approximately 2 million inhabitants (a post-conflict census has not yet been carried out). Kosovo is characterized by a complex geological construction, which has also conditioned the creation of a wide spectrum of resources including metals, non-metal energy resources, inert materials and mineral waters. In past decades, the economy of Kosovo mainly relied on the mineral processing industry, including production of lead, zinc, silver, gold, and other metals, energy, textiles and agriculture. Kosovo's economic development depended on the developed metallurgical and mining industry for internal consumption as well as for export. Besides this, in Kosovo, especially in KEK (Energetic Sector) and in Trepca, the mining and metallurgical industry was the biggest employer and the suspension of work there has caused negative social effects in Kosovo. Today, the economic development of Kosovo is at a very low level and restarting the mines and metallurgy activities as well as building new industries are essential for the further development of Kosovo. The environmental status of Kosovo is dominated by a range of issues including polluted air, soil and water and poor infrastructure management generated mostly by the lack of an environmental protection regime in the past. The level of many atmospheric pollutants exceeds accepted international standards, for example at the TPP near Prishtina and from dust from industrial activities in the Mitrovica region, in which there is a high amount of lead, cadmium, arsenic, nickel, etc. Compared to Central European countries, Kosovo could be considered a territory with many environmental problems.

2. Energy Activities

After the recent conflict the Kosovar government strengthened the energy sector through financing the repair and security of the energy supply. The government also took more responsibility for providing or mobilizing funds to ensure that energy supply capacity was expanded to meet future demand. In 2006, with the Energy Strategy and Kosovo Development Strategy and Action Plan, energy supply had turned into a socio-economic and strategic matter.

2.1. CURRENT SITUATION IN THE ELECTRICITY SECTOR

The electricity sector in Kosovo is dominated by the power generation company, KEK, a vertically integrated system. The integrated electricity system is composed of two lignite mines at Bardh and Mirash, and two TPPs, Kosovo A and B, with an overall effective capacity of from 645 to 710 MW (from an installed capacity of 1,478 MW), network transmission and dispatching, distribution network and supply. The TPPs, Kosovo A and B, an industrial site about 3 km from Prishtina, is a place where a number of activities affect the environment of the immediate and surrounding areas. The most important from an environmental point of view are the mining of lignite, power generation and gasification (the plant stopped production about 10 years ago but has never been decommissioned).

2.1.1. Lignite Reserves

There are two major lignite basins – the Kosovo lignite basin and the Dukagjini lignite basin – in addition to smaller lignite basins such as Drenica, Malishevë, Babush i Muhaxherëve and one potential lignite basin in the southern part of Kosovo with exploitable lignite reserves of good quality. The estimated lignite quantity is between 11.55–14 billion tons. These lignite reserves have a low sulfur content and a relatively good concentration of lime (calcium oxide) for partial sulfur absorption during burning. The proportion between the waste land and lignite is very favourable, a fact that makes the mines very attractive for exploitation.

Key parameters of lignite basins:

- Area: 19.7 km^2
- Geological reserves: 990 million tons
- Exploitable reserves: 830 million tons
- Overburden to coal ratio: 0.9 m^3:1 t
- Average coal seam thickness: 75 m

Two open mines of lignite (Bardh and Mirash) have operated since 1963–1964. Currently these two mines supply two power plants with approximately 7 million tons of lignite per year. According to the most recent estimates, the existing mines will be completely exhausted in 2007–2009. This figure is dependent on the intensity of energy generation compared to the lignite reserves in existing mines.

2.2. THERMAL POWER PLANTS

The installed technical capacities of the two TPPs could have been sufficient to meet Kosovo's current demands for electricity. However, due to the recent history and improper maintenance during the years both before and after the conflict, the security and generation capacity of the TPPs and their equipment have been seriously damaged. As a result, existing available capacities are reduced significantly specifically at TPP Kosovo A (Table 1). A vast part of the generating units at TPP Kosovo A are in very weak operating condition and consequently have low generating capacity as a result of failures and unexpected breakdowns.

TABLE 1. Existing TPP in Kosovo (KEK as of May 2005).

Installed		Net	Net available		
		Kosovo A			
Unit A1	65	58	30–40	Lignite/oil	1962
Unit A2	125	113	0	Lignite/oil	1964
Unit A3	200	182	0	Lignite/oil	1970
Unit A4	200	182	0	Lignite/oil	1971
Unit A5	210	187	95–110	Lignite/oil	1975
		Kosovo B			
Unit B1	339	309	260–280	Lignite/ heavy oil	1983
Unit B2	339	309	260–280	Lignite/ heavy oil	1984

Participation of households and services has increased from 26% to 75% and from 7% to 13% respectively, whereas the industry percentage has decreased from 67% to 12%. The overall number of KEK consumers has been estimated to be around 360,000. Electricity consumption comprised 64.2% of the supplied electricity, therefore creating a huge load during the winter season. The above mentioned situation, regarding the supply in the electricity sector, has put KEK into a very unstable economic situation, with limited financial capabilities for fulfillment of its own duties.

Other problems that aggravate the situation are:

- Lack of financial means for rehabilitation and revitalization, and current dilemmas concerning which generating units need revitalizing and which need to be closed down
- The process of restructuring and reorganizing including incorporation
- Long term problems with environmental pollution
- Unresolved status of the KEK management
- Political instability for foreign investors

KEK has increased its electricity production by 15% over the last 2 years. This is about the same percentage as the increase in coal production (Table 2). Public consumption of electricity as fallen by 20% in the same period, whereas commercial consumption grew by 7%. Imported electricity fell by 13%, whereas export of electricity grew by as much as 30%.

The only important plant outside of KEK is the hydropower plant in Gazivoda/Ujmani (2 × 17.5 = 35 MW). It is administrated by the water company Hydrosystem Ibër-Lepenc.

TABLE 2. Coal and electricity production (Table made by the author based on the data from KEK).

		Electricity (MWh)				
					Consumption (MWh)	
Year	Coal production (t)	Production	Imports	Exports	Public	Commercial
2004	5,658,333	3,481,054	650,640	194,665	1,489,978	649,239
2005	6,391,139	3,999,767	490,641	225,755	1,447,864	661,460
2006	6,532,348	3,970,511	537,816	253,297	1,458,605	696,511

2.3. TRANSPORT

The transport sector is characterized by a large number of old vehicles and the use of low-grade fuel. The number of vehicles registered in Kosovo is an indication of the amount of emissions. Overall, the number of registered vehicles went up by 18% in 1 year. The majority of these vehicles are private cars, which went up by 5%. The other categories vary quite a bit and probably there has been some confusion with the categorisation.

Railways are not electrified in Kosovo. This means that trains run on diesel. No data are available as of yet on the total mileage of trains. The diesel engines contribute to local air pollution and noise nuisance (Table 3).

Air traffic contributes to local air pollution and noise nuisance. It also contributes to global problems such as global warming and destruction of the ozone layer. Air traffic in Kosovo is growing at 6% per year (based on number of flights). This means that Kosovo's contribution to global warming is increasing as well. On a local level this means more noise nuisance from air traffic and more air pollution at ground level from taxiing.

3. Environmental Issues Related to Power Generation and Transport

Based on similar older TPPs the currently unmeasured emissions of gases from the TPPs consist of high levels of carbon dioxide, NOx, dust, etc. Due to the lack of maintenance of industrial waters, TPPs cause water pollution as well. Temporary storage of ash presents specific problems as storage can reach over 40 million tons and occupy around 150 ha of land as do the craters which are created during the exploitation of coal in the open mines of lignite. Ash from TPP Kosovo A is transported in open stripes and stored in designated storage areas where it is not protected from spreading into the air from the wind nor polluting the water through leakage. There are serious disproportions between the exploitation dynamics and revitalization of exploited surfaces.

There is no permanent functioning monitoring system of harmful emissions to the environment. Due to huge electricity demands, the activity is

TABLE 3. Rail infrastructure (km).

Public transportation (passengers)	333
Industrial transportation	97
Total	430

tolerated even when legal norms and conditions for environmental protection are not met.

3.1. EMISSION

The energy sector of Kosovo is an enormous polluter, especially in the wider region around Prishtina but also at the regional and global levels.

Coal fires and combustion processes lead to the generation of emissions to air, water and soil, of which emissions to the atmosphere are considered to be one of the main environmental concerns. The most important emissions to air from TPPs are SO_2, NOx, particulate matter, heavy metals and greenhouse gases.

3.1.1. Fires Due to Self Combustion of Lignite in Coal Reserves

The main environmental effects of spontaneous combustion of lignite are:

- Greenhouse gas emissions such as.CO_2, CH_4, NOx
- Emissions of toxic gases such as CO_2, N_2O, SOx
- Destabilization of mine slopes

About 3 million tons of lignite are likely to be burnt every year. **2.1.2 Power Plant Kosovo A**

The plant's problem with dust emissions is serious and apparently cannot be resolved without the major redesign of the boilers and electrofilters. An assessment of possible reduction in dust emission shows that the Kosovo A units will not comply with current EU regulations, even after the recommended actions are taken. Units in Kosovo A are already at the end of their lifespans and further investment in these units is of questionable value.

3.1.2. Power Plant Kosovo B

Considering that the remaining lifetime of the B units is quite long, the harmful effects of fine dust particles on human health, the bad operation of existing electrostatic precipitators and the relatively low cost of dust control equipment, the rehabilitation of filters is proposed to take place by 2008.

3.1.3. Ash Landfill

The territory containing the KEK facility and its sterile dumpsites of ashes includes around 150 ha on which around 40 million tons of ashes were dumped, becoming a major source of air pollution.

3.1.4. Emissions from Transport

Though no precise data exists, most of the vehicles in Kosovo can be considered to be old. The estimated pollution load from traffic is calculated (Table 4).

4. Air Quality

The information available is subject to uncertainties, due to the lack of an air monitoring system in Kosovo, including the self-monitoring system at the level of polluters, which makes the real assessment of air pollution difficult.

Air quality measurements taken at two points in the area of the TPP include concentrations of air motes, SO_2 and soot.

Simplified dispersion calculations are performed for dust based on data obtained from the Meteorological Institute.

The calculations are performed for dry conditions. In the case of rainfall, the highest pollution levels will be found much closer to the site. The wind is 65% of the time blowing from the direction NNW–NSW with wind speed averages as low as 2–3 m/s and very seldom more than 5 m/s. This means that for Kosovo A, with stacks reaching a height of about 100 m, most of the pollution can be found at a distance between 15 and 25 km from the plant. For Kosovo B, with a stack height of about 180 m, most of the pollution can be found at a distance between 35 and 45 km from the plant but at a level of about 45% of the concentration calculated for Kosovo A. When we combine these results we get the picture shown above which shows a maximum emission between 20 and 40 km from the site. However, it needs to be mentioned that the wind direction and wind speed can be different at a height of 100 m as compared to a height of 180 m and this is not considered in the above simplified calculations.[1]

[1] Environment Impact Assessment and Action Plan for Kosovo A and B Power Plants and Coal Mines, June 2003, Carl Bro-Intelegen= Solution.

TABLE 4. Estimated pollution load from road traffic (Table made by the author based on the data from Ministry of Transport and Telecommunication).

Type	Fuel	Age	No. of vehicles	km/ year	Dust	Emissions factors (g/km) SO_2 NOx CO hydro-carbons				Dust	Emissions (t/ year) SO_2 NOx CO			Hydrocarbons
Vehicle	Gasoline	Up to 90	100,683	16,000	0.1	0.2	2	32.88	2.1	161,092	322.18	3221.85	5,296.3	338.29
Vehicle	Diesel	Up to 90	77,000	16,000	1	2	1	32.82	–	1,232	2,464	1,232	40,409	–
Truck/ bus/ van	Diesel	Up to 90	37,821	16,000	1.5	3	3	–	–	907	1,815	1,815	–	–
									Total	2,300.92	4,601.1	45,705.3		

(Taking into account the lack of emissions controls on vehicles in Kosovo, the value was estimated based on the formula: no. of vehicles × km. × emission factor = emission product).

Chart 1. Exploited coal, 2005 (Chart made by the author based on the data from KEK)
Chart 2. Energy production/month, 2005 (Chart made by the author based on the data from KEK)
Chart 3. Vehicle distribution per region (Chart made by the author based on the data from Ministry of Transport and Telecommunication)
Chart 4. Dust emission from TPP, Kosova B, 2005 (Chart made by the author based on the data from KEK)
Chart 5. CO_2 from 2005 (Chart made by the author based on the data from KEK)
Chart 6. NO_x emission, 2005 (Figure made by the author based on the data from KEK)
Chart 7. SO_2 emission, 2005 (Figure made by the author based on the data from KEK)
Chart 8. Ash production,2005 (Chart made by the author based on the data from KEK)
Chart 9. Vehicles in Kosovo regions (Table made by the author based on the data from Ministry of Transport and Telecommunication)
Chart 10. Air mote concentration (Chart made by the author based on the data from KEK)
Chart 11. SO_2 concentration (Chart made by the author based on the data from KEK)
Chart 12. Soot concentration (Environment Impact Assessment and Action Plan for Kosovo A and B Power Plants and Coal Mines, June 2003, Carl Bro-Intelegen = Solution)

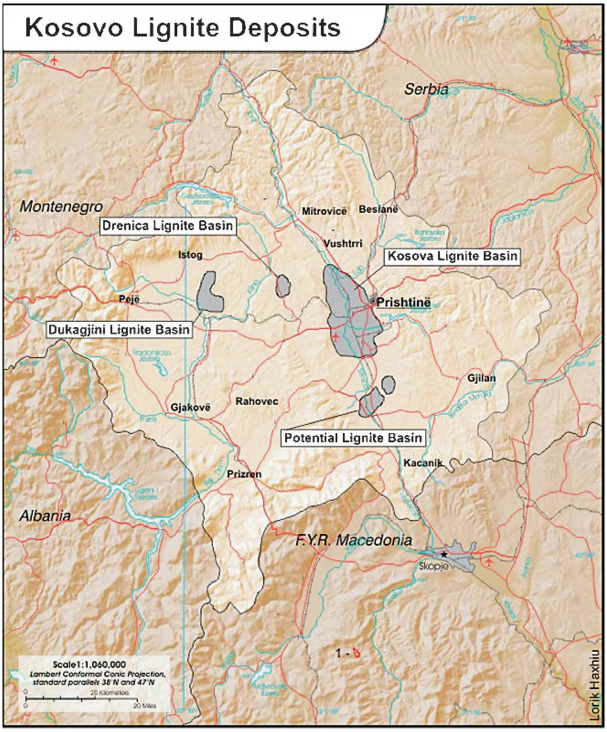

Figure 1. Lignite resources in Kosovo (Lignite Power Development).

5. Sustainability in Energy Sector Development

Kosovo's lignite reserves are Kosovo's biggest natural resource. Exploiting them with modern technology will allow Kosovo to generate a sufficient and reliable electricity supply while respecting the environment.

Development of the mining and energy sector is key in Kosovo's long-term economic development strategy as it will improve the quality of life, create jobs and reduce poverty.

In November 2002, UNMIK signed the Athens MoU for the creation of the South East Europe Regional Electricity Market. In December 2003, UNMIK signed a second MoU, which further included the creation of a regional gas market and a proposal for a common environmental approach. A recent study funded by the European Union CARDS Programme, the "South East European Generation Investment Study" (GIS) considers that one of the lowest cost generation options in the context of the Regional Electricity Market is a set of new high efficiency clean coal technology lignite-fired power plants. The study concluded that in the context of the South East European Regional Electricity Market (SEE REM) during the 2005–2020 horizon a total capacity of 3,700 MW could be added. The SEE REM will create a new reality for the development of the electricity sector of Kosovo, as shown in the GIS study. This offers significant opportunities for Kosovo in attracting investors to develop export oriented TPPs while improving the security of supply through power exchange arrangements (Kosovo Strategy of Energy).Kosovo was the first territory to ratify the Energy Community Treaty (ECT) in late-2005 (signed on 25 October 2005).

The main challenges and preconditions when considering the stabilization and immediate functioning of the electro system in Kosovo as well as the establishment of an environmental management system have been presented above.

The legal and administrative framework is not yet fully developed and the avoidance of the adoption of an overall environmental policy led to several difficulties in the establishment of a proper environmental system in Kosovo.

To date, the following laws and decrees have been adopted or are in procedure for adoption:

- The Law on Environmental Protection 2003/9
- Administrative Instruction on Environmental Impact Assessment
- The Law on Energy
- The Law on the Energy Regulator
- The Law on Electricity
- The Law on Mines and Minerals
- The Law on Air Protection
- Administrative Instruction on rules and standards of discharges to air from stationary sources of pollution
- Administrative Instruction on air quality standards (in procedure)
- Administrative Instruction on norms of discharges to air from mobile sources of pollution (in procedure)
- The Law on Trade of petroleum and petroleum products
- Administrative Instruction on quality of liquid petroleum products

5.1. THE MAIN STRATEGIC GOALS FOR MITIGATING POLLUTION FROM THE ENERGY SECTOR

Based on the analysis of the current situation including energy demand, strategic objectives for the development of energy for the 2005–2015 period are:

- Improvement of the economic sector through finalization of KEK restructuring.

- Increase of efficiency in ensuring needed financial resources and the efficient management of investments with emphasis on creating attractive conditions for international investors who need to participate in financing up to 60% of the overall investments in this sector.
- By 2012, regional centres of Kosovo will have district heating and regional gas systems.
- Restoration of consequences to the environment caused by TPPs by 2010 and thorough implementation of high norms and standards of environmental protection during the construction of new capacity for electricity generation meeting the obligations found in the Kyoto protocol.
- Establishment of a monitoring system and electronic database.
- Increase of awareness of the benefits of rational utilization of energy and usage of alternative energy sources.
- Significant increase of domestic capacities for research and development. and
- Implementation of advanced technology and modern management within institutions and public energy enterprises.

6. Conclusions

The above mentioned problems cannot be solved without undertaking serious measures in the restructuring of the energy sector in general. Restructuring of the electricity sector can ensure operation on a commercial basis and can relieve competition in the electricity market in Kosovo. This would enable the overcoming of the above mentioned problems, resulting in efficient use of current assets of lignite and electricity.

Environmental protection in Kosovo is facing big challenges. It is necessary to support economic and sustainable development, effective infrastructure and environmental balance and achieve effective and efficient use of land and natural resources in a way that will prevent conflicts of economic and ecological interests.

Kosovo's prosperity, our standard of living and our quality of life will be greatly influenced by how we extract, transform, allocate, and consume our energy resources.

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TRANSBOUNDARY ENVIRONMENTAL CHALLENGES

MULTINATIONAL APPROACHES: A TOOL FOR THE PREVENTION AND REDUCTION OF THE RISKS OF NUCLEAR ENERGY

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Abstract: The renaissance of atomic energy breathed new life into the idea of International Nuclear Fuel Cycle Centers. In the last 2–3 years states, and international and non-governmental organizations came up with more than a dozen initiatives in this field. According to IAEA experts, among the numerous proposed multilateral approaches to NFC, the Russian initiative on creating an International Uranium Enrichment Center (IUEC) is the most advanced in terms of national legislation and movement toward practical implementation. Russia sees the creation of the IUEC as a *pilot* project to perfect, in cooperation with the IAEA, the creation of international centers that would render NFC services. The initiative of international centers does not eliminate all the risks connected with nuclear energy and will not solve all non-proliferation problems. However, it can offer a new basis for reducing such risks.

1. Introduction

The World Nuclear Association predicts that by 2020 the installed nuclear power plant capacity in the world will have increased from 370 to 430 GW. The world now has 439 nuclear reactors and plans for building 158 new reactors have been announced.[1] The result of such growth will be an increased demand for enriched uranium because the majority of existing and projected power plants use uranium enriched to 3.5–4% for U-235 isotope as a fuel, as well as growing amounts of spent nuclear fuel in the world.

At the same time, the world market in nuclear plants is experiencing a massive expansion of international cooperation. For example, the US company *Westinghouse* has been acquired by the Japanese *Toshiba*, *General Electric*

[1] Plans For New Reactors Worldwide. World Nuclear Association. August 2007. http://www.world-nuclear.org/info/inf17.html. Accessed 27 October 2007.

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has formed an alliance with *Hitachi*, another Japanese company, *Mitsubishi*, is cooperating with the French *Areva*, which also owns the nuclear branch of the German company *Siemens. Toshiba* is trying to forge an alliance with the Kazakhstan company *Kazatomprom* and the Russian *Tekhsnabexport*.

All that, coupled with another crisis of the non-proliferation regime caused by the desire of some states to gain access to sensitive nuclear technologies bypassing the current export control rules, revives interest and the prospects of the creation of International Nuclear Fuel Cycle (NFC) Centers.

2. NFC Initiatives

The concept of international centers providing nuclear fuel cycle services was first proposed in the 1970s in the wake of the crisis of the nuclear non-proliferation regime triggered by India's nuclear test in 1974 and was connected with the energy crisis that forced many countries to consider expanding their nuclear power programs. In expectation of a surge in the development of nuclear energy worldwide, various initiatives were put forward to create international centers connected with the more sensitive stages of the nuclear fuel cycle: uranium enrichment and spent nuclear fuel reprocessing. The key task of international centers was to prevent the uncontrolled proliferation of nuclear technologies that could be used not only for civil but also for military purposes.

Politically, the idea of multinational nuclear facilities was first widely aired in 1975 at the First Nuclear Nonproliferation Treaty Review Conference. The Conference's final declaration noted that multilateral and regional NFC centers could provide a way to satisfy, safely and economically, the needs of many states in the nuclear field, while at the same time facilitating physical protection and application of International Atomic Energy Agency (IAEA) safeguards.[2]

In the late 1970s and early 1980s a series of studies was carried out into the possibilities and prospects of multilateral approaches to the NFC. In the 1970s the most promising area of nuclear energy development was thought to be the closed nuclear fuel cycle and "plutonium economics". Accordingly, the bulk of the research into the possibilities of tighter monitoring of the NFC on a multilateral basis was concentrated at the time on its final stages – the reprocessing and handling of spent nuclear fuel, and the storage of radioactive waste.

In 1975–1977 the IAEA looked into the prospects of creating *Regional Nuclear Fuel Cycle Centers* (RNFCC). The study considered the economic aspects, physical security and compliance with IAEA safeguards in terms of

[2] Carlton, Stoiber (2003). The Evolution of NPT Review Conference Final Documents, 1975–2000. *Nonproliferation Review*, Fall/Winter, 140.

possible multilateral approaches to the final stages of the nuclear fuel cycle (handling of spent nuclear fuel and radioactive waste).[3]

From the economic point of view the creation of major centers for the reprocessing of spent nuclear fuel may result in economies of scale. The study used various models to compare participation in RNFCCs and independent national development of the corresponding sectors. Calculations show that for countries with small nuclear programs participation in regional projects makes economic sense.[4]

Other advantages of the multilateral approach may include:

- *Reduced risk of nuclear incidents caused by poor management and training*. The proposed international NFC centers would not give foreign experts access to the technological elements of the plants. That reduces the risk of incidents in the nuclear industry caused by poor management and training in those countries that have just started to develop nuclear energy.
- *Consolidation of nuclear materials and technologies on a limited number of sites*. The reduction of the number of facilities that have sensitive nuclear technologies as well as nuclear materials reduces the risk of their proliferation.

However, the numerous initiatives of multilateral approaches to the NFC proposed in the 1970s–1980s did not lead to practical results. The main obstacle to their implementation was the reluctance of the majority of states to forgo their sovereignty and expose national security to a threat in such a sensitive area as nuclear energy.

3. Current Initiatives in the Field of Multilateral Approaches to the Nuclear Fuel Cycle

The idea of international NFC centers was resurrected in the early 2000s in the context of another nuclear non-proliferation crisis and the renaissance of nuclear energy.

In the middle of the 2000s, a number of states as well as non-governmental and international organizations came up with a series of proposals aimed at creating international NFC centers.

- On February 22, 2005, IAEA disseminated its *Expert Group Report on Multilateral Approaches to the Nuclear Fuel Cycle* – a proposal to establish a nuclear fuel bank under the administration of the IAEA.

[3] Logutova, Nadezhda (2005). On New Initiatives in the Area of Nuclear Materials and Technologies Control. *Yaderny Kontrol*, 78 (4), 101.

[4] Ibid.

- On January 25, 2006, Russia's President Vladimir Putin suggested an *Initiative to create a system of international nuclear fuel cycle centers*.
- On February 6, 2006, the *US Global Nuclear Energy Partnership* (*GNEP*) was announced by the US Secretary of Energy Samuel Bodman. It offers assured nuclear fuel supply in exchange for a commitment to forgo the development of domestic uranium enrichment and spent fuel conversion capacity.
- On May 31, 2006, a *Concept for Reliable Access to Nuclear Fuel* by states opting to rely on the international market for nuclear fuel rather than having domestic enrichment activities was offered by six countries with commercial uranium enrichment activities.
- On September 1, 2006, Japan announced an initiative to establish a system called the "*IAEA Standby Arrangements System for the Assurance of Nuclear Fuel Supply*" under IAEA auspices.
- On September 19, 2006, U.S nongovernmental organization Nuclear Threat Initiative made *a proposal to set up a reserve of low-enriched uranium* and offered US$50 million for this purpose.[5]
- In September 2006, German Federal Foreign Minister Frank-Walter Steinmeier proposed the creation of an international uranium enrichment facility – operated by the IAEA – at an extraterritorial (international) site.[6]

4. President Putin's Initiative

On January 25, 2006, addressing a meeting of the Eurasian Economic Community (EurAsEC),[7] President Putin of Russia proposed creating international centers to provide nuclear fuel cycle services.

In accordance with the Russian President's initiative, four types of centers would be created in Russia[8]:

[5] More on the NTI initiative in Holgate, Laura (2007). A Proposal for a Nuclear Fuel Reserve. *Security Index*, 82 (2), 157–160.

[6] Tariq Rauf, Head, Verification and Security Policy Coordination, "Multilateral Approaches to the Nuclear Fuel Cycle and other proposals", New Framework for the Utilization of Nuclear Energy in the 21st Century: Assurance of Supply and Non-Proliferation, Vienna, 6 February 2007.

[7] The Eurasian Economic Community (EurAsEC) is an international economic organization created to form external customs borders of its member countries (Belarus, Kazakhstan, Kyrgyzstan, Russia, Tajikistan and Uzbekistan), and to work out a common foreign economic policy, tariffs, prices and other elements of a common market. EurAsEC is the legal successor to the Customs Union.

[8] Sergey Ruchkin, Deputy Director, Department of Strategic Analysis, *Tenex*. "Nuclear Nonproliferation and International Uranium Enrichment Centre". Presentation at the International Conference "G8 Global Security Agenda: Challenges & Interests. Towards the St.-Petersburg Summit", 22 April 2006. http://www.pircenter.org/index.php?id = 222. Accessed 29 October 2007.

- Uranium enrichment
- The handling of spent nuclear fuel
- Training of personnel in the atomic energy field
- Development of innovative atomic energy technologies[9]

As a first step in the implementation of the Russian President's initiative it was decided to create an International Uranium Enrichment Center (IUEC).

Russia is the world leader in providing industrial uranium enrichment services, possessing, according to different estimates, between 40% and 45% of the world capacity employing competitive separation technologies.[10] Its enterprises have been using the method of centrifuge enrichment on an industrial scale since 1964, which is 30 times more energy-efficient[11] than its predecessor, the diffusion method,[12] which is still used in separation plants in France and the US.

In the middle of September 2006, Russia officially notified the IAEA that an international uranium enrichment center would be created on the basis of the Angarsk Electrolysis Chemical Combine[13] located in Eastern Siberia 130 km from Lake Baikal.

The Angarsk project is the youngest centrifuge facility in Russia. Its separation capacity currently stands at 2.6 million SWUs which is equivalent to the production of fuel for 22–26 VVER-1000 reactors (or its Western design PWR-1000).

In the spring of 2007 the Angarsk project was put on the list of facilities in Russia where IAEA safeguards may apply. Earlier the plant was dropped from the list of "restricted facilities," which enabled Russia to start negotiations to put the Center under the IAEA safeguards.

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[9] Kirienko: Russia can do with one uranium enrichment center. *RIA Novosti*, 8 February 2006.

[10] See "Agreement on the Creation of an International Uranium Enrichment Center Signed in Kazakhstan Capital Today". Nuclear Industry Information and Exhibition Activities Center. 10 May 2007. http://www.rosatom.info/ru/new_news/lent/index.php?id8 = 1400. Accessed; 27 October 2007; "Vice Premier Sergei Ivanov and Rosatom head Sergei Kirienko pay official visit to Vladimir Oblast on April 20." Nuclear Energy and Industry Press Center. 20 April 2007. http://www.rosatom.ru/news/4419_20.04.2007. Accessed 27 October 2007.

[11] Vaulina, Irina (2007). Half Century in Service. *Podrobnosti Newspaper*, 8 February.

[12] Gas Centrifuge Uranium Enrichment. http://www.globalsecurity.org/wmd/intro/u-centrifuge.htm. Accessed 27 October 2007; http://www.wise-uranium.org/nfceuh.html. Accessed 27 October 2007.

[13] Transcript of a meeting of deputy director of the Federal Atomic Energy Agency (Rosatom), Chairman of the Commission for the Creation of an International Uranium Enrichment Center, Nikolai Spassky, with representatives of the Government and non-governmental organizations in Irkutsk Oblast. Angarsk, 29 September 2006. http://baikalwave.eu.org/1Econews/newssent06.html. Accessed 21 October, 2007.

On May 10, 2007, a Russia–Kazakhstan Agreement on the creation of the International Uranium Enrichment Center was signed in Astana in the presence of Russian President Vladimir Putin and Kazakhstan's President Nursultan Nazarbayev. Under Russian law, the IUEC was founded as an open joint stock company (OAO). Under the terms of the agreement, Russia owns 90% of the shares in IUEC and Kazakhstan 10%. In fact, Russia has kept the shares that may in the future be acquired by the countries wishing to join the project. But Russia will retain the controlling stake in the IUEC (50% + 1 share).

5. Assured Nuclear Fuel Reserve

The creation of international NFC centers under international control makes it possible to guarantee supplies of nuclear materials (a nuclear fuel bank) for the countries which do not have their own enrichment facilities.

The main thrust of the initiative to create a nuclear fuel bank is to offer the countries which are pursuing peaceful nuclear energy activities, but which do not have uranium enrichment and fuel production plants, additional assurances of fuel supplies which would address the problems connected with their possible termination for political motives. Such assurances can be based either on creating fuel stocks accessible in the event the main supplier (physical fuel bank) fails to perform under the contract, or on the obligation of the producers to reserve parts of their output for the same purposes (virtual fuel bank).[14]

Three incidents of refusing to supply nuclear fuel under effective contracts are known in world history. In 1977, the US and Britain cut off supplies of fuel for the research reactor in South Africa as part of the boycott of that country. In the second half of the 1970s, the US refused to supply nuclear fuel to Brazil in protest of that country's plans to set up a closed NFC. At about the same time the US refused to supply nuclear fuel to India because it had carried out a nuclear test in 1974.[15]

The issue of creating a mechanism of assured supplies of nuclear fuel was first discussed within the Committee on Assurances of Supply, which worked within the IAEA framework between 1980 and 1985.

[14] Logutova, Nadezhda (2006). The Prospects for the Realization of Multilateral Approaches to the Nuclear Fuel Cycle. *Yaderny Kontrol*, 79 (1), 88–89.

[15] Anton Khlopkov, Executive Director of the PIR Center, "International Initiatives in the Field of Guaranteed Nuclear Fuel Supply", Workshop "Multilateral Initiatives in the Field of Guaranteed Nuclear Fuel Supply: Perspectives for Implementation", Moscow. 25 April 2007.

As part of the IUEC, Russia plans to create a guaranteed stock of nuclear materials under IAEA management. The initial reserve will be about 120 t of 4% enriched uranium, enough to load one and a half 1,000 MW reactors.

Fuel from the bank would be supplied to a particular country pursuing a nuclear energy program by IAEA decision whenever market mechanisms fail, i.e., when the enricher and the market cut off supplies due to political motives.[16]

According to the head of the Federal Atomic Energy Agency, Sergei Kirienko, the nuclear fuel reserve will make it possible to perfect a mechanism of assured supplies and will mark a first step towards creating a future world atomic energy infrastructure.[17]

One cannot rule out that the Russian initiatives will be implemented in conjunction with other proposals. For example, consultations have been held between Rosatom and the Nuclear Threat Initiative with the participation of the IAEA on the possible joint creation of a guaranteed reserve of nuclear fuel in Angarsk.[18]

6. Potential Participants in the Angarsk Project

The initiative to create the IUEC initially envisaged that a state participating in the International Center would forgo its national enrichment program.[19] However, some countries, including Argentina, Australia, Canada, Kazakhstan, Ukraine and South Africa, indicated during the course of their consultations with the IAEA that they were not ready to forgo the right to enrich uranium in the future. Besides, Brazil and Iran, which are actively pursuing R&D in the field of centrifuge enrichment, as well as Japan, which has small enrichment capacities, are unlikely to renounce their right to develop their own separation facilities.[20]

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[16] "The IAEA Board of Governors may approve the Guidelines of the IUEC nuclear fuel bank as early as the first half of 2008." *Interfax-Kazakhstan*. 19 September 2007.

[17] Kornysheva, Alyena, Butrin, Dmitry (2007). Russia Will Neutralize Energy-related Conflicts with Uranium. *Kommersant*. 19 September.

[18] Nunn, Sam (2007). Nuclear Deterrence Theory Is Not Applicable to Nonstate Actors. *Security Index*, 82 (2), 34.

[19] Sergey Ruchkin, Deputy Director, Department of Strategic Analysis, *Tenex*. "Nuclear Nonproliferation and International Uranium Enrichment Centre". Presentation at the International Conference "G8 Global Security Agenda: Challenges & Interests. Towards the St.-Petersburg Summit". 22 April 2006, http://www.pircenter.org/index.php?id = 222. Accessed 29 October 2007.

[20] Tariq Rauf, Carnegie International Nonproliferation Conference, 26 June 2007. http://www.carnegieendowment.org/files/fuel.pdf. Accessed 21 October 2007.

In this connection a more flexible approach was recommended whereby renunciation of a national enrichment program was a *welcome*, but not a mandatory condition. The preamble to the Russian-Kazakhstan agreement on the creation of IUEC also mentions that Kazakhstan does not currently have its own enrichment facilities.

Thus, under the proposed new scheme any country seeking to develop atomic energy would be able to acquire enrichment services at the International Center.

Potential participants in the IUEC can be divided into three main categories.

First, the countries which are only developing atomic energy and do not have enough expertise or economic and political motivation to create their own national separation facilities. That group includes *Belarus*, *Vietnam*, *Egypt*, *Indonesia*, *Morocco*, *Turkey* and *the Persian Gulf countries*.

Second, the countries which are developing nuclear energy but currently prefer to acquire separation services in the world market. Such countries include *Armenia*, *Ukraine* and *South Korea*.

Third, the states which have their own enrichment facilities but need additional enrichment services to develop nuclear energy or are developing an enrichment industry but have not yet reached capacities to meet all their national needs. That group includes *Brazil*, *Iran*, and *Japan*.

7. Conclusion

The renaissance of atomic energy, coupled with another nuclear non-proliferation regime crisis, breathed new life into the idea of International Nuclear Fuel Cycle Centers. In the last 2–3 years states, and international and non-governmental organizations came up with more than a dozen initiatives in this field.

According to IAEA experts, among the numerous proposed multilateral approaches to NFC, the Russian initiative on creating an IUEC is the most advanced in terms of national legislation and movement toward practical implementation. Russia sees the creation of the IUEC as a *pilot* project to perfect, in cooperation with the IAEA, the creation of international centers that would render NFC services.

The creation of the IUEC is important but merely a first step in implementing a multilateral approach to the NFC. Given nuclear fuel, the issue of what to do with spent nuclear fuel is sure to arise soon. And one of the most attractive solutions is the creation of an International Enrichment Center with spent nuclear fuel. This is envisaged by the initiative of Russian President Vladimir Putin on creating international centers for rendering NFC services announced at the EurAsEC Summit in January 2006.

It has to be admitted that the initiative of international centers does not eliminate all the risks connected with nuclear energy and will not solve all non-proliferation problems. However, it can offer a new basis for reducing such risks and resolving current non-proliferation crises. One option for resolving the situation around Iran's enrichment program may be its participation in the work of the International Center in exchange for its consent to limit the development of a national separation facility in Natanz.

The creation of international NFC centers can also offer the participants in the project assured supplies of nuclear fuel as well as dividends in the economic, political and, in the longer term, environmental spheres.

THE SECURITY–ENVIRONMENT NEXUS ALONG THE CZECH-AUSTRIAN BORDER: THEORY, SPATIALITY AND PERCEPTION

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Abstract: This analysis deals with the issue of the security–environment nexus in the Czech-Austrian border region (Znojmo-Retz Area). This research uses investigative tools from both the natural and social sciences. The issue is examined at three interconnected planes: first, there is a theoretical plane dealing with the notion of environmental security (ES) in existing literature. Specifically, focus is paid to the heuristic utility of the so-called Environmental Degradation-Conflict Thesis. After its problems are exposed, a conceptual and theoretical shift is suggested in order to correct for its deficiencies. Second, the notion of spatiality is introduced and discussed. The key term here is cultural spatiality. Our original typology of cultural landscape units is provided and their main characteristics are specified. The typology is subsequently applied to the assessment of existing environmental hazards in the region. Thirdly, environmental security is looked at through the lens of social research. This plane has thus in its centre the perception of environmental security by local stakeholders. The perception of environmental security of the Znojmia as seen by the Czech stakeholders and the perception of environmental security of the Retzerland as seen by the Austrian stakeholders are compared and contrasted. The conclusion terminates the analysis proposed below.

Keywords: Environmental security, human security, transborder region, Austria, the Czech Republic, cultural spatiality, environmental perception

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1. Introduction

Our analysis deals with the issue of the security–environment nexus in the Czech-Austrian border region spanning between the cities of Znojmo, Czech Republic, and Retz, Austria.* The matter is investigated at the levels of both natural sciences and social sciences and thus the reader is provided with an interdisciplinary vantage point. The nature of this research, in turn, determines the methodology used, which rests on the notion of methodological pluralism. We examine the issue at three interconnected planes: first, there is a theoretical plane which deals with the notion of environmental security (hereinafter referred to as ES) in existing literature. Specifically, the focus is on heuristic utility of the so-called Environmental Degradation-Conflict Thesis which has been most frequently associated with ES. After its problems are exposed, a conceptual and theoretical shift is suggested in order to correct for its deficiencies. As a part of this, our use of people-oriented ES is justified. Second, we discuss the notion of spatiality in the analysed issue. The key term here is cultural spatiality. We provide an original typology of cultural landscape units in the transborder region and specify their main characteristics (Table 1). The typology is subsequently applied to the assessment of existing environmental hazards in the region. Thirdly, ES is looked at through the lens of social research. This plane has thus in its centre the perception of ES by local citizens and stakeholders. The perception of ES on the Czech side as seen by the Czechs and the perception of ES of the Austrian side as seen by the Austrians is compared and contrasted. Finally we reach certain conclusions.

2. Environmental Security as the Environmental Degradation-Conflict Thesis and Its Critique

The Environment Degradation – Conflict Thesis has been closely tied to the "Environmental Change and Acute Conflict Project" (ECACP) based at the University of Toronto, Canada, and run by Thomas Homer-Dixon. This author puts forward a strong argument:

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*The help of 26 bachelor students of geography enrolled in the course "Urban and Rural Studies" at Masaryk University with data collection for this article is gratefully acknowledged. Also, we would like to thank Christian Schrefel and Regina Hajszan from 17&4 GmbH Wien for their help with practical arrangements of interviews on the Austrian side and Petra Karvánková, a doctoral student of geography at Masaryk University, for her contribution to section 5 of this chapter. Last but not least, the financial support of the Czech Academy of Science (grant identification number KJB708140803) is gratefully acknowledged.

TABLE 1. Cultural landscape spatial units – A typology.

1. The highland	2. The highland/lowland edge – the scarp	3. The lowland
A Dyje/Thaya Canyon	D Znojmian	F Pulkau
A1 Kaja-Liščí r ock	D1 Znojmo centre	F1 Schrattenthal
A2 Šobes	D2 Znojmo north crescent	F2 Hüttenberg
A3 Znojmian	D3 Znojmo south crescent	F3 Pirzling
	D4 Havraníky	F4 Pulkautal
B The Dyje/Thaya Forestland		
B1 Lower Fugnitz	E Retzian	G Retzbach-Daníž
B2 Kaja/Thaya revier	E1 Retzbach/Obernalb	G1 Retzbachland
B3 Čerchov/Klinka	E2 Retz	G2 Schatzberg
B4 Konice/Hnanice stretch		G3 Šibeničky
B5 Haber/Spittelmaiss		G4 Daníž valley
C Agrarian fringe		H Vrbovec/Načeratice
C1 Mašovice		H1 Vrbovec
C2 Niederfladnitz		H2 Načeratice

> My key finding is straightforward: … Scarcity of renewable resources – what I call *environmental scarcity* – can contribute to civil violence, including insurgencies and ethnic clashes … [I]n the coming decades the incidence of such violence will increase … (Homer-Dixon, 1999, p. 177)

Homer-Dixon's project has by far been the most influential attempt to reveal causal relationships between environmental scarcities on the one hand and the probability of conflict occurrence on the other. It is clear from his writing that Homer-Dixon *denotes* the notion of ES to the environmental degradation-conflict thesis (also, cf. Timberlake, 1985; Westing, 1988; Abdel Rahim, 1991; Boulding, 1991; Romm, 1993; Bächler, 1998; Bächler and Spillman, 1996). The entire project is a comparison of more than 16 different case studies and they are all analysed with the same research tools. First and foremost, Homer-Dixon's methodology rests on the empiricist tradition in the philosophy of science and his epistemology and methodology are informed by qualitative positivism. Homer-Dixon and his collaborators have developed a typology of conflicts: they essentially distinguish between intrastate, which is the main focus of their research, interstate and global. Another criterion is the regional one – Homer-Dixon then speaks about centre-periphery, cross-boundary, water conflicts and migration-induced conflicts. What all these conflicts allegedly have in common is their occurrence in what is being termed 'crisis areas' (e.g. water conflicts in dry lands, etc.).

In his 1994 article published in the journal *International Security*, Homer-Dixon distinguishes between six types of change which are plausible causes of violent inter-group conflict: (1) Greenhouse-gas induced climate change; (2) Stratospheric ozone depletion; (3) Degradation and loss of good agricultural land; (4) Degradation and removal of forests; (5) Depletion and pollution of fresh water supplies; and (6) Depletion of fisheries (Homer-Dixon, 1994, p. 6). Homer-Dixon used three hypotheses to establish a link between these changes and violent conflict. The first was based on the argument that decreasing supplies of environmental resources (e.g. clean water or good agricultural land) would provoke interstate simple-scarcity conflicts, also termed as resource wars. The second hypothesis put forward an argument that large-scale movements of "environmental refugees" would cause group-identity conflicts, specifically along ethnic lines. The final – third – hypothesis then suggested that deepening environmental scarcity would lead to economic deprivation and eventually to the disruption of the main social institutions (Homer-Dixon, 1994, p. 7).

Overall, Homer-Dixon's approach is informed by systems theory as known in political science through the work of David Easton. Environmental scarcity (by which is meant scarcity of renewable resources) has thus in Homer-Dixon's scholarship three causal forms: degradation, which is supply induced, increased demand, which is obviously demand induced, or unequal resource distribution. The contributing factors are then said to be resource capture (by elites), and/or ecological marginalisation of the have-nots and the poor in general; additionally, the latter is often suggested to be the effect of the former. As Peluso and Watts (2001, p. 13) correctly point out, it is Malthusian population growth that appears to be the universal driving force in all causal links that have previously been created. In other words, the argument comes full circle. Moreover, the environmental degradation-conflict thesis is a mere manifestation or recurrent pattern of cultural ecology thought, with one significant addition – that is an attempt to draw global conclusions out of what has been seen as a local instinct for an automatic resort to war whenever the socio-ecological system 'demands' such an outcome. This has been true for both the scientific approach represented by Homer-Dixon as well as the more political stance of Kaplan (1994).

The entire environment degradation-conflict thesis does not, perhaps surprisingly, transcend the confines of the nation-state. It remains in thrall to the logic of the nation-state as the paramount referent object needing to be secured. This is clear, for instance, in Kaplan's (1994) vision of the danger of what he calls "reprimitivized violence" for US *national* security. The same applies to Homer-Dixon – these people are not interested in ES, or insecurity, as such. Rather, they limit their understanding of the environment to Malthusian-informed environmental *scarcity* and resource wars: violent conflicts are portrayed as a result of the two. They, for example, do not ask themselves the important question of what scarcity means here. Are they talking about *strategic* scarcity, perhaps important for the economic interests of developed countries (reserves of oil, precious metals etc.), or about *real* scarcity, as experienced by the local people who inhabit these areas? Is there any inevitable connection between the two? From their analytical vantage point, they do not care about real scarcity so much, if at all: what matters is the former.

There is another, equally important question: can one tie the complex web of ES to the notion of environmental scarcity? Put differently, can one say anything important, meaningful and of practical utility to the environment and local people inhabiting it, about environmental security under the categories of environmental scarcity and degradation and violent conflict? Interestingly, there have been no case studies conducted on so-called developed countries.

Does this mean that the citizens of the developed states (rather than the states themselves) are safe, i.e., are experiencing the state of ES? The answer is no. Nothing like this can be said precisely because all the focus of analysis within this discursive strand denoting the term ES into a banal and wrong environmental degradation-conflict thesis does not focus on individuals. The entire conceptual universe here is exhausted by the image of nation states as referent objects that need to be secured, which is pitted against the reality of failure of these referent objects in some areas (mainly in Africa). When it comes to asking the question "What about the citizens or individuals: are people secure vis-à-vis their environment or surroundings?" the answer is: we cannot say within the conceptual categories and discourse informed by this thinking. What is then needed is a different conceptual tool, an approach, a set of arguments and linkages which can say something relevant about the ES of people. That is the subject of the following section.

3. Theoretical and Conceptual Shifts Made for the Conduct of Our Practical Research

To begin with, due to the aforementioned deficiencies, a different conceptual and analytical framework informing one's analysis is needed. This is nothing less that the redefinition of security (McNamara, 1968; Galtung, 1982; Ullman, 1983; Holst, 1989; Matthews, 1989; Mische, 1989, 1992; Myers, 1989, 1993; Dabelko and Dabelko, 1995; Conca and Dabelko, 1995). Since our project investigates what ES means for people living along the border between two Central European countries (Austria and the Czech Republic), any approach that would be able to answer this question needs to be (1) people-oriented and (2) underlined by interpretive methodology.

The approach that would be able to say something new and original about the borderland area in question also clearly needs to transcend the flawed discourse on environmental-degradation-conflict thesis. It cannot, first of all, focus on scarcity since it is a very problematic and deliberately ambiguous term. It can be said that the developed world would never experience *actual* scarcity as many areas in the developing world already do, but rather *strategic* scarcity. The main reason is the potential of the Western world to develop innovative technologies – as a corollary, one can invoke Brock's (1991, p. 410) argument that scarcity is often determined by politics rather than by the "physical limitation of natural resources." Secondly, the denotative discursive strand is useless for our research purposes (or, more generally, for the examination of ES in the developed world) as we do not analyse any situation which would inevitably include a violent conflict or at least severe acts of civil disobedience (with the notable exception of Austrian environmentalists in their ongoing campaign to shut down the Czech Temelin power plant).

The approach we argue for at this point is the reflection of what Elliott (2004) calls the demilitarisation of ES, or a "securing-the-environment approach". Unlike the first tradition tying the notion of ES to environment degradation-conflict thesis, this strand of thought treats the environment itself as the paramount security goal and referent object. This approach has the clear advantage of being compatible with discourses on human security and the environment (Hynek, 2008). It can be conceived of as an approach reinforcing the need to contextualise ES, mostly by creating and reinforcing the bond or nexus between environment and development agendas (also, cf. Mathews, 1991).

The research conducted in the Retz/Znojmo borderland area was informed by the notion of *glocalisation*. This term links previously disparate levels of analysis – in concrete terms, the level of international environmental policy-making mainly, but not exclusively, taking place within the United Nations, with the level of local political and social practices related to ES (Lipschutz, 1997). It is precisely this link that 'begs' for a genealogical analysis with its elucidation of the background abilities (themselves the product of ES discourses) of actors involved in activities germane to the state and processes of ES in the area. The connoting approach to ES, which suggests new conceptual possibilities, has informed our practical research on ES in the Retz/Znojmo borderland area. One of the chief aims of our research design has been the comparison of changes in the environmental situation in both parts of the Austrian/Czech borderland after the fall of the Iron Curtain in 1989, with a special emphasis on environmental loads as well as risks and hazards. Since our take on ES in the area has been people-centred, we conducted a number of interviews, arranged a series of meetings with local stakeholders and established a joint Czech-Austrian research group to

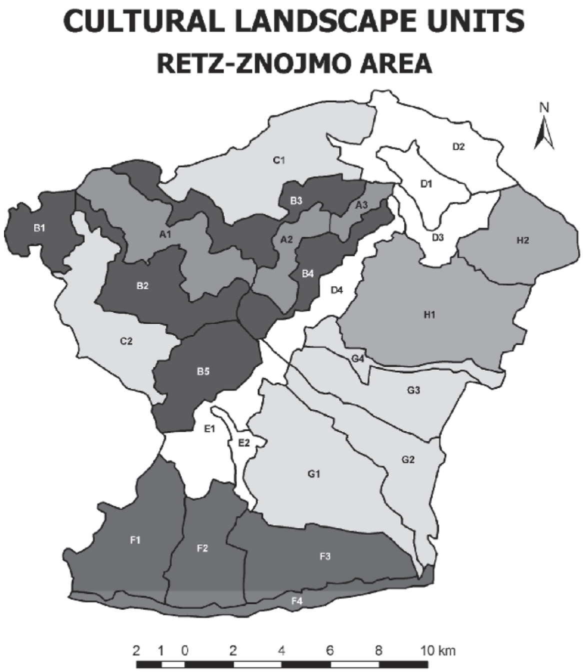

Figure 1. Cultural landscape spatial units – A map

examine the social side of the issue. Also, our research, though done according to strict academic standards, is intended for people in the area – that was the reason for us holding two workshops with a wide range of local actors and public participation.

As the following sections show, our approach to ES has been twofold: Firstly, we tried to incorporate a physical-geographical/environmental survey into our research (sections 4 and 5). Specifically, the survey contains characteristics of both physical and cultural landscape ecosystems through GIS and digital maps (Figure 1). Secondly, we have established a close rapport with local communities in order to find out details about their environmental perception of the Retz/Znojmo region (section 6). This was done through social research methods and the function was to complement the findings of physical geography and environmental science.

4. Cultural Spatiality of the Znojmo/Retz Transborder Region

The settlement area includes Czech and Austrian parts with a commonly shared border. There are two dominant urban areas – the towns of Znojmo and Retz. Znojmo is situated in the south-west corner of South Moravia County (Jihomoravský kraj) within the district of Znojmo, and Retz is located at the northern edge of Lower Austria (Nieder Österreich) represented by the political district of Hollabrunn.

Our study area includes:

- The Znojmia region – the town of Znojmo, including its administrative districts of Derflice, Konice, Načeratice, Oblekovice, Popice, Přímětice, and the other settlements of Bezkov, Dobšice, Dyjákovičky, Dyje, Havraníky, Hnanice, Chvalovice, Kuchařovice, Lukov, Mašovice, Nový Šaldorf – Sedlešovice, Podmolí, Suchohrdly, Šatov, Tasovice, and Vrbovec, covering 23.5 km^2 and including 46,740 inhabitants (2003). The urbanized area of Znojmo has 33,441 inhabitants, and the town of Znojmo itself has 29,121 inhabitants
- The Retzland – the town of Retz with surrounding villages of Oberretzbach and Mitterretzbach; the northern settlements of Unterretzbach, Kleinriedenthal Ragellsdorf, Obernalb, Unteralb, and Obermarkersdorf; the town of Hardegg with villages of Merkersdorf and Niderfladnitz; and the southern settlements with three centres: Pulkau, Zellerndorf and Haugsdorf, plus the villages of Schrattenthal, Pillersdorf, Rohrendorf, Dietmannsdorf, Deinzendorf, Watzelsdorf, Pernersdorf, Karlsdorf, Pfaffendorf, Peigarten and Jetzelsdorf, covering 304 km^2 and including 14,542 inhabitants. The municipality of Retz has 4,168 inhabitants within a territory of 45.01 km^2, and the town of Retz itself has 2,529 inhabitants

This part will outline the features of the physical and cultural landscapes of this area and is the continuation of research from the 1973–1978 landscape survey (cf. Hynek and Trnka, 1981), across the Czech-Austrian border as far as the Pulkau stream. We did a new landscape survey and recognized a double symmetry in the Znojmo-Retz landscape: the Highland – Scarp- Lowland sequence from the West to the East and – since the Dyje river has a common Czech-Austrian section – the Dyje river/Pulkau stream watershed.

5. The Retz/Znojmo Area Environmental Security Assessment

The prevailing role of man as a dynamic factor in the development of a landscape has both positive and negative environmental and ecological effects in the investigated region of Retzerland/Znojmo. This study describes some of the important human impacts in the Czech-Austrian border region, which are sources of risk for basic ecosystems and their self-regulation as well as feedback for the human population.

5.1. THE HIGHLAND

5.1.1. Dyje/Thaya Canyon (A)

This unit consists of the partially forested protected areas of two national parks, the National Park Thayatal in Austria and the National Park Podyji in the Czech Republic. The environmental problems concerning both parks include undisciplined tourists (mainly Czech bicycle riders on the Austrian side who do not respect the park regulations), and the unrestricted accessibility of the whole park area by hikers on both sides of the border. The influence of human factors is visible even in the most protected park regions; therefore, species and habitat protection from anthropogenic disturbances is necessary. Another problem is the unbalanced regime of the Dyje watercourse through the insufficient regulation of water discharge from the Vranov dam. The Vranov power station causes a rapid water level increase of about 1.5 m twice a day and subsequently the washing away of close-grained sediments and water temperature variations. Natural bed evolution with gritty benches and gradual bands was discontinued. Nowadays the treed bands are steep. A specific problem of the National Park Podyji is augmentation of illegal junkyards with rubble from building sites and homes. Logging is allowed in certain parts of the National Park Podyji, which causes the dislocation of forest ecosystems by heavy machines. The risk of floods has increased in the Dyje valley in the last few years. Local floods present a great danger for built-up areas. The negative influence of the Vranov reservoir (see above) is multiplied by the influence of the subjacent Znojmo reservoir. The construction of these reservoirs changed the riverbank plants: a large part of the forest around the river was chopped down. Moreover the riverbed near the reservoirs was canalised and concreted over.

5.1.2. The Dyje/Thaya Forestland (B)

This unit consists mainly of forests. These are subject to various categories of environmental protection corresponding to the zones of national parks. It is a cross-border unit comprising the forest localities of Čerchov and Klinka, surrounding the vine growing towns of Konice and Hnanice on the Czech side and on the Austrian side the forest district of Kaja/Thaya, Haber/Spittelmaiss and the surroundings of the lower Fugnitz brook.

The biggest risk factors endangering the local ecosystems, both natural and cultural, are floods, in particular, high water events on smaller local water runs. As an example, on June 30th, 2006, the flood on the Fugnitz brook caused by several days of heavy rains destroyed a large part of the town of Hardegg and its vicinity within a matter of minutes. The forests have been damaged by the use of agricultural chemicals over long periods. These chemicals are washed out and down from the surrounding agricultural landscape. On the Czech side, the character of the landscape is disrupted by a number of old, dilapidated houses and farmsteads, which have been unused for a long tim e and are decaying and becoming overgrown. Illegal waste dumps in the local forests present another man-made environmental hazard.

5.1.3. Agrarian Fringe (C)

This unit represents a fringe of mainly arable land surrounding the forested landscape of the protected zone of both national parks. On the Czech side, this intensively used agricultural landscape is represented by the immediate surroundings of the town of Mašovice. On the Austrian side, it is the area around Niederfladnitz. Long-term intense agricultural usage has left visible traces on the landscape. Heavy soil erosion is supported not only by human activities (inadequate ploughing, large blocks of arable land, growing of erosion-supporting crops, etc.), but by climatic factors as well. The whole area belongs to the dry thermophilic pannonian region, with low rainfall and the occurrence of dust storms. The large blocks of arable land without a marked network of biocorridors and windbreaks increase the effects of wind erosion. The fields cannot resist the negative effects of heavy rains, and soil sheet wash is common. What is more, the biodiversity of the whole area is now quite low. A monotonous, flat, agrarian landscape prevails, without balks or any other interaction elements. The dynamic natural elements of this landscape unit are water runs, forming smaller natural units of the landscape, i.e. the valleys of the Gránický and the Mašovický brooks, with a risk of local floods becoming more common.

Another serious natural hazard in this landscape unit is posed by stone production. As an example, the quarry of Mašovice, ca. 5 km west of Znojmo, was a direct threat to the natural landscape of the national park when it was in regular operation. However, the end of stone production did not bring any improvement. Within its operation, the question of its position close to the protective zone of the National Park Podyji was most often discussed, as the natural landscape of the park was being affected by falling stones, noise and heavy vehicle traffic linked to the transport of stone. Nowadays, the quarrying has stopped and there was an unauthorized recultivation of the quarry by repositioning the drainage of the brook. This is causing constant changes of the water level in the lake that developed on the bottom of the quarry, so the quarry remains a point of groundwater pollution. The quarry disturbs the landscape character, and it is a dangerous place for tourists and children, because the whole area in the immediate vicinity of this stone quarry is undermined, so there is a risk of collapse.

5.2. THE HIGHLAND/LOWLAND EDGE – THE SCARP

5.2.1. Znojmian (D)

The city of Znojmo is among the oldest cities of the Czech Republic. Its favorable geographical position at the interface between wide lowlands and sylvan upland has attracted mankind for more than 50,000 years. The place has been inhabited uninterruptedly since the arrival of the Slavonic tribes in Moravia in the 6th century. A new part of the history of Znojmo started in November 1989. Almost the whole Znojmo region had been affected by the Communist state policy beforehand, as it fell, together with a part of the National Park Podyji, within the border zone. The border zone, established in 1948 in front of the "iron curtain" separating Czechoslovakia from the "western" European countries (i.e., even from Austria) meant strict control of the movement of people until the Velvet Revolution of 1989. It has to be said that the prohibition of entry of people to this border zone greatly contributed to the natural potential of the landscape.

These days, 17 years after socialism ended, Znojmo again plays the role of a centre of great importance for a large part of the Czech-Austrian border region, and it is expected that it will become a centre of services even for a large part of Austria. Its economy is definitely stronger than the nearby Austrian city of Retz. Even so, the unemployment rate of 12% is among the highest in the Czech Republic. The city and the suburbs are still developing slowly; the people living in the protection zone of the national park are starting to use the potential of the park to develop their entrepreneurial activities, including undertakings in leisure travel, transport, etc. This brings, among other things, new environmental risks and stress for this natural–cultural landscape, which has been, up to now, only scarcely modified and exploited.

The heavy long-distance traffic, going right through the city centre, is a decisive factor greatly decreasing environmental quality in the city area. Apart from air pollution and noise, the enormous number of vehicles presents a hazard to the city's populace. The current route of I/38 through the city centre is regarded as the most critical point of the transport infrastructure of the city. A bypass of the city has been planned for some time. The construction of it, however, has not started yet, due to cases of unclear ownership of property and to protests of the owners of the affected areas, mostly in the neighbouring towns (Přímětice, Dobšice). The problematic safety of some heavily used crossroads is also a weak point in the road transport. At present, many cars park in the centre of the city. People are used to parking their cars near the centre and sometimes even on the pavements.

The best known environmental danger in the Znojmo region is floods, partly because of the strong promotion in the media of this problem. A flood in 2006 affected mostly second homes and orchards located in the floodplain of the river Dyje. The flood caused a series of hazards to the local people such as disease dissemination by animals and plants in diluvia mud or the invasion of weeds. Another danger for the inhabitants of Znojmo is presented by the large number of homeless people who live at Kraví hora. It is a potential source of the dissemination of contagious diseases, such as phthisis, moulds and ulcers.

The most serious danger for the character of the landscape is presented by vineyards illegally founded by businessmen within the holdings of the National Park Podyji. The park administration is under pressure from these businessmen who are interested in its land. Very often it is the case that an already established vineyard is later granted a permit in irregular proceedings.

5.2.2. Retzian (E)

In this region, farmers lived in harmony with nature before the fall of the iron curtain. However, the situation before the iron curtain fell was concurrently characterised by severe erosion and inappropriate exploitation of the landscape. Monocultures were more widespread than nowadays. Today 90% of the farmers of the Retzerland receive state subsidies for their farming. The use of pesticides is uncommon today. Chemical agriculture is more expensive for the farmers, but on the other hand, it means less work by hand for them. Many Austrians have a firm relationship to the land and to the soil, although they are not farmers.

The traffic is also a big load on the landscape and endangers ES. The local population is being constantly damaged by freight passing directly through the town, by noise and exhaust pollution. The Retzian landscape unit is known for its sacral and unique landscape which is largely safe from crime. Industrial sources of environmental hazards are reduced as there are neither factories nor heavy industry. As far as environmental awareness is concerned, the environmental education of children and their parents is of a high quality.

5.3. THE LOWLAND

5.3.1. Pulkau (F)

The local landscape is predominantly used for agriculture. However, the landscape is exposed to a higher risk of soil erosion, an aspect which is supported by local climatic effects. There is a potential risk in the whole region of the disappearance of water resources due to extreme drought and very high summer temperatures. Also, the local arable land and smaller vineyards are exposed to the risks resulting from heavy rains.

The local, predominantly agricultural landscape is imperilled by strong winds causing soil erosion. The effects of strong winds are eliminated by lines of solitary trees and shrubs along the roads or by holding covers in the middle of agricultural land. The fields are exposed to an extremely dry climate with a great amount of dust storms or rainstorms which wash out arable topsoil into close brooks. A mosaic of individual fields is complemented by small vineyards, which are also exposed to climatic extremes.

5.3.2. Retzbach-Daníž (G)

This unit is strongly interlaced by a network of smaller streams (the Lanbach, Retzer-Albach, Retzbach, Nalber Bach, and Seebach) and their inflows. Therefore, there is a risk of flooding from these streams passing through local villages. The bank vegetation of some brooks is neglected, the brooks are overgrown by cane and other large weed plants and they become at some places the source of local contamination.

The vineyard slopes are greatly endangered here by soil erosion and fertile soil sheet wash, which consequently harms the stability of these slopes. Also, there is a danger of heavy rain, black ice and heavy snow. Disease dissemination by plants and animals may occur where grape vines are located. The climate is again warm and dry with different temperature increases during the day at various parts of the slopes according to their orientation. On slopes with a southern aspect there is a risk of natural conflagration, or burning of vegetative organs of the plants such as desiccation, due to insufficient humidity.

The road E 59/2, which passes through the region, contributes to a great extent to local pollution. Heavy traffic due to the E 59 brings a lot of environmental risks such as noise stress, exhaust, waste along the road, overloading of the roads, etc. In connection with the international route E 59 there is also the risk of high criminality connected especially with illegal sex tourism, casinos, betting and selling of smuggled goods in the markets. This is one of the reasons why young people are not interested in purchasing very cheap building land in this area and why the social decline of this marginal part of the Znojmo region continues. This road is deeply cut into neogen sediments and suffers from large landslides. Heavy traffic due to the nearness of the Austrian-Czech border crossing at Hatě is a menace to vineyards and fields in the immediate vicinity of the road, due to noise stress, exhaust fumes and traffic jams.

5.3.3. Vrbovec/Načeratice (H)

Most of the significant natural hazards in the area are bound to this heavily used arable land area. The landscape is to a great extent deforested and highly agriculturally utilized. Long-term utilization of agrochemical products such as fertilizers brings many risks. These products contribute to the death of a variety of plants and animals, besides which they pollute local waters and toxically burden the soil. Large agricultural areas without any network of biocorridors or other interactive elements are directly exposed to the effects of wind erosion and heavy rain and therefore they suffer greatly from sheet wash of the fertile layer of soil as well as mechanical damage to the vegetative organs of cultivated plants.

There are particularly striking levels of pollution in winter due to coal combustion. A big danger to ES and the rules of permanent tenability is presented in the Vrbovecký region by man himself. The lower education of the local population contributes to a large extent to the high rate of unemployment (15%). It is a socially very weak region. The local people are not interested in environmental protection and associated issues. The question of the protection of nature is not important from their standpoint.

One of the most striking dangers in this landscape unit is presented by the rubbish dump on the top of Načeratice hill. The hill represents a remarkably changed elevation of crystallinicum and is situated roughly 1 km from Znojmo. It was for a long time a training area for tanks. This use stimulated the occurrence of xerothermic vegetation. The rubbish dump was reclaimed in 2004 but is still being illegally used by the local people. Due to the many illegal dumps the hill cannot be used in other ways such as a possible tourist sightseeing point. Moreover, on the steep artificially made slopes, there is a risk of landslide. Landslides also occur on the banks of the Dyje in the neighbourhood of the village of the same name. The northern banks are, due to their southern aspect, exposed to stronger sunshine and due to extreme drought they present a potential risk of grass burning and change of vegetation cover (xerophile plants). Because of the nearness of Znojmo the local landscape suffers from the consequences of heavy traffic, such as noise stress, exhaust fumes, and overloading of the roads. There is also significant air pollution during winter due to coal combustion.

6. Social Research on the Perception of Environmental Security in the Borderland Area

The previous section used the perspective and methods of the natural sciences, namely of environmental science and physical geography, to assess the state of the environment in the studied landscape units. Nevertheless, the research does not stop here as one of its aims is to complement this knowledge by social research. How do local inhabitants think about their environment?

How is the knowledge gained through the use of objective natural sciences complementary to that produced by sociological methods? What issues do citizens identify as sources of threats to their lives? What is the difference between Czechs and Austrians as far as the perception of their environment is concerned?

This section presents conclusions based on the findings from our own primary social research. The data are aggregated at the level of the Czech part of the region and the Austrian part of the region. The combination of four methods of data collection and analysis was used: questionnaires, personal interviews, focus groups, and thematic media analysis. The use of standardized semi-structured questionnaires containing 15 questions was aimed at urban and rural inhabitants in the region. Spatial representativeness of answers was ensured by the division of 26 students of geography enrolled in the course "Urban and Rural Studies" at Masaryk University, who conducted the inquiry, into eight groups of three (one group was composed of five students), with each group allocated to one of the eight existing landscape units (A–H; see section four for an overview). Each group gave the questionnaire to ten people who were selected through a snowball sample technique; 80 interviews in total were obtained. Additionally, a series of 18 semi-structured elite interviews was conducted personally by the authors of this article: nine on the Czech side and nine on the Austrian side. The aim was to target key stakeholders in the local public sphere; the list of interviewees and their professions can be found at the end of this chapter.

Moreover, the findings were further complemented by data collected from two focus groups which were held as a part of two workshops organized in Znojmo, Czech Republic, and Retz, Austria, respectively. The pool of issues was drawn from the questionnaires. The Znojmo focus group was held on May 17, 2006, in the Znojmo Town Hall. The participants were 28 students from the Karel Polesny Secondary Grammar School and eight local stakeholders, mainly representatives of the municipal government and people active in local environmental issues. The focus group was jointly moderated by Mrs. Mittnerova, a teacher from the above school, Bretislav Svozil, a doctoral student of geography at Masaryk University, and Alois Hynek. As for the Retz focus group, it was organized in the local secondary-grammar school (Gymnasium Retz) on October 20, 2006. Twenty-one students from the gymnasium as well as seven local stakeholders, predominantly representatives of the municipal government and people active in local environmental issues, participated in the discussion moderated jointly by Mr. Silberbauer, a teacher at the above institution, Christian Schrefel of 17&4 GmbH Wien, and Alois Hynek. Finally, we used a qualitative method of thematic analysis of topics pertinent to ES contained in the local printed media, specifically in the semi-monthly newspaper *Znojemske Listy* during the period between January 2004 and September 2006.

What follows is an outline and discussion of the main concerns for local inhabitants and stakeholders as far as ES is concerned.

6.1. ENVIRONMENTAL SECURITY ON THE CZECH SIDE AS SEEN BY LOCAL CITIZENS AND STAKEHOLDERS

As far as the general level of ES was concerned, a majority of respondents as well as many articles in the local newspapers suggested that the region was rather safe. They did, however, acknowledge the existence of various situational vulnerabilities, both natural and man-made. When asked to identify the main natural hazards, they usually pointed to local tornadoes and stormy eddies which damaged their houses and cottages in the past. They were seen as particularly dangerous due to their unpredictable occurrence and an obsolete system of early warning. The danger of flooding was often listed as one of the disasters people were afraid of, but was rarely selected as the worst problem. This stands in stark contrast to the way the region has been portrayed at the national level, i.e. as a region suffering from acute threat of flooding. A number of interviewees maintained that they lived with occasional floods for centuries and it was almost business as usual for them. As for environmental threats caused by humans, the danger of fires was seen as a considerable problem and so was the lack of advanced procedures to sort waste, with the latter resulting in waste dumping in wild areas. Many respondents also pointed out the connection between these two topics as many bad fires in the area actually started from illegal burning of waste.

When it came to the discussion of energy security, the respondents' answers were in stark contradiction to the usual media representations of the region in international TV coverage (especially in Austria). Although the issue of nuclear energy was often mentioned, people did not feel threatened by it too much: the majority had a positive to neutral attitude to the nearby Dukovany nuclear plant and the same was true for the Temelin nuclear plant. They generally believed in the safety of the plants and often gave us arguments about their reliability (in the case of the modern Temelin plant they referred to its chosen technical solution and in the case of the older Dukovany plant built during the communist era they quoted its unproblematic history). Surprisingly, this was also the case with people active in the environmental movement and local environmental politics. Czech environmental activists, some of them still students, also pointed out that diverging opinions about the nuclear plants were hampering more intense cooperation with fellow environmental activists from Austria. A much more significant source of environmental insecurity was identified, that being the impact of increasing prices of energy on the dangerous habits of local inhabitants, both in urban and rural areas. Specifically, a number of people were concerned about the return of a large proportion of local communities to burning low-quality brown coal and in some cases even plastics.

An oft-cited source of environmental insecurity was connected to allegedly dubious agricultural practices on the Czech side of the region, namely the overuse of chemicals in agricultural production. Although a number of respondents were pleased with the consolidation of the shift from state/cooperative farms to private enterprises and linked it to the relative decline of the use of chemicals, they in the same breath added that it was still not enough. They felt threatened by the infiltration of chemicals into the drinking water (the Vranov Dam). Additionally, inhabitants in rural areas complained about limited water filtering and cleaning in their villages. When asked about genetically modified crops, a majority of people did not perceive them as a real threat, as a kind of Frankenstein food. The only disapproving attitudes were, perhaps surprisingly, recorded among the younger segment of the population, particularly students from urban areas, but even the students were not too radical in the framing of this issue.

Another high-priority issue regarded the National Park Podyji, established by a change of its status from a landscape protected area into a national park in 1991. With 50 personnel working for it and its strong reputation for focusing on research, it was quite a surprise that a number of local citizens said they disliked its existence and practices. Most people quoted the very tough conservationist approach of the park to the use of its territory by local inhabitants as the main obstacle in mutual communication. They felt unnecessarily restricted even in mild outdoor activities there. What they appreciated, on the other hand, was the strong opposition of the park administration to a planned dam on the Dyje River near Byci skala.

Finally, the Czech respondents were asked about their opinion on the efforts of municipal officials in reducing environmental insecurities. A high proportion of the respondents criticized the officials for not doing enough as far as the promotion of environmental awareness was concerned. They complained about weak environmental education within their local communities, both formally at schools and workplaces and informally through civic associations and nongovernmental organizations. The environmental activists who were familiar with the most pressing problems stressed the need to improve insufficient environmental initiatives that were generally fragmented and lacked any sense of clear and consistent strategy. Also, they criticized the proliferation of quasi-environmental businesses which were not, according to these respondents, fulfilling their declared objectives. When asked about instances of policy transfers from the more environmentally-aware Austria, the respondents could neither recall any initiative they had heard about, nor would express complaints about too formal or artificial attempts to establish a transborder dialogue.

6.2. ENVIRONMENTAL SECURITY ON THE AUSTRIAN SIDE AS SEEN BY LOCAL CITIZENS AND STAKEHOLDERS

Our findings on the Austrian side were rather different from the Czech side in quite a number of issue areas. When asked to list the greatest sources of environmental insecurity, the majority of the respondents actually started with global environmental issues, or at least issues with worldwide occurrence (for the difference, cf. Sandbrook, 1997). Among these, the issues of climate change and energy security loomed large. It was interesting to see how a number of the respondents connected these two global issues to their local concerns, showing a great degree of environmental awareness and education. Climate change was linked to the local danger of floods, taken by all the respondents very seriously. Although many pointed to quite a long history of floods, they also emphasized their growing unpredictability. There was no radical difference between urban dwellers (Retz) and rural inhabitants in the region. Efforts by the municipal government regarding the development of a modern system of early warning were appreciated.

As for the issue of energy security, three clear trends could be discerned: First, nuclear energy was not seen as an option as far as energy security was concerned; second, opinions of Austrians were formulated negatively, in direct opposition to Czech practices (a more general trend visible in other issue areas discussed below); and third, recent international debates about energy security were seen to further Austrian efforts to diversify energy sources and to invest into local, independent and sustainable solutions. Virtually all respondents (young and old, urban and rural) fiercely opposed the existence of the two Czech nuclear plants. Since the dismantling of the iron curtain in 1989, public protests on the Austrian side took place regularly. The most popular form of protest was the blockades of border crossings between the two countries.

Although it was no surprise that the vast majority of the respondents considered the building and use of Czech nuclear power stations as the biggest danger to ES, the direction of their hostility was much unexpected. The existing strongly negative attitudes were, surprisingly, against the new, technically more advanced Temelin plant which is, on top of that, geographically much farther away than the Dukovany power plant. The old Dukovany plant, located only a few tens of kilometres from Retz, was mentioned very rarely. When asked about this counter-intuitiveness, the respondents replied that they perceive it as a relic of the communist regime in the former Czechoslovakia and therefore did not frame it as a current issue. They also hinted that it could be the reason why Austrian media campaigned actively against the Temelin plant, rather than against the Dukovany plant. According to the respondents, it was possible to stop the process of building the Temelin plant, which was not the case with the older Dukovany plant built at a time when public opinion did not matter in what was then Czechoslovakia. A number of people mentioned one small but vociferous non-governmental organization in Retz constantly protesting against the Temelin power plant. During our focus group, we received their materials claiming that the Temelin nuclear plant emitted radiation in the form of radioactive wind. They threatened tourists who came to Retzerland to breathe fresh air, saying the area was radioactive. However, there was no such measurement proving this and the whole issue was rather an example of firm ideological beliefs.

It was in this context that the respondents defended renewable energy as the best source of energy. Many of them said they started to use new, renewable forms of energy, particularly pellets, straw, and solar energy and resorted to strategies of district heating too. The municipal government initiated and supported many of these projects. The officials emphasized the fact that 20 new private solar panels were introduced in households over a year. We were told that the local government supported everybody who liked to use solar energy: by then, there were already 100 solar panels installed in private households and one installed in a public swimming pool. We learned about the existence of two district heating plants in Retz – one solar plant and one straw plant; they supplied 80–90 households with energy. At the same time, however, a number of respondents, especially from rural areas, highlighted the limits of renewable sources. In concrete terms, they criticized a wind park (a cluster of wind plants) near Hollabrunn for two reasons. First, the noise these plants produced was found disturbing; second, these respondents disliked the wind park on aesthetic grounds as allegedly intruding upon one's pleasure from the surrounding landscape.

Agricultural practices were often mentioned as another source of environmental insecurity. There were three issues quoted by the respondents as the most pressing: arid landscape, lack of groundwater and genetically modified crops. Many respondents criticized the municipal government for not doing enough with the issue of arid landscapes, specifically, initiating a wider debate on this topic and suggesting what could be done about it. A connected issue was lack of water. Apart from low levels of underground water, a number of respondents in rural areas, as well as some of the officials, acknowledged the existence of frequent transborder "water wars" which included the case of water pumping from the National Park Podyji to Austria by a Czech entrepreneur. The existence and sound management of the National Park Thayatal was often cited as an achievement of harmony between nature conservation and sustainable tourism. Its positive influence on the reduction of the use of chemicals and an increase in bio- and organic agriculture was stressed. As for genetically modified crops, they were seen as a bane for local agriculture by the respondents across the board. Many people expressed their fears in light of the lifting of the European moratorium previously banning their production and use. Moreover, local inhabitants, especially farmers, were scared by the possibility of the transmission of genetically-modified seeds and pollen to their fields from the Czech side of the region.

Finally, the issue of transborder cooperation, environmental awareness and education was raised repeatedly during the inquiry. A number of the respondents – including local government officials, cited the problem of the lack of cooperation with Czech citizens and officials and their answers suggested a clear sense of mutual distrust, particularly due to the nuclear energy issue. The same was the case with environmental activists from the two countries – they did not cooperate for the same reason. The general level of environmental awareness among the respondents was high. Local environmental activists were not, perhaps surprisingly, young people, but seniors and middle-aged people. They established six to seven civic groups or associations with the aim of spreading a sense of responsibility for the environment among their fellow citizens. As far as environmental education was concerned, we learned that it started in kindergarten and was treated as an important subject at schools. The young people who were interviewed were environmentally educated, but not too environmentally active. Paradoxically, a number of activists seemed to be less educated about the environment than the students we talked to. The best environmental education could be found among urban dwellers.

7. Conclusion

ES in the way we understand it and practise it represents a new and dynamic topic linking previously separated realms of the political/social with the environmental/ecosystem, thereby strengthening the concept of sustainability in what is otherwise a risk society. The key assumption is that ES should be aimed at individuals and communities and solved locally, and only those issues that cannot be solved at the local level will be passed onto other levels in a multi-level governance structure (reflecting an informal principle of subsidiarity). The major advantage of this approach is that it provides us with an integrative perspective on individuals and communities as an important part of landscape ecosystems.

In this contribution, we tried to bridge two approaches which have largely been used separately, rather than in combination: the cultural-landscape approach resting on some insights from natural sciences, most notably physical geography and environmental science (but also reflecting the impact of human activities on a given territory, i.e. land use), with the approach empirically examining the social dimension of the region. While the first approach was aimed at the investigation of environmental hazards in the studied region, the second used qualitative techniques to ascertain the perception of ES by local inhabitants and stakeholders. We believe this is the way forward in doing a comprehensive piece of research which is both scientifically rigorous yet socially informed.

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The List of Interviewees (Personal Elite Interviews Conducted by the Authors)

Oldřich Kraipl, Deputy-Mayor of the city of Znojmo
Martin Škorpík, Management of the National Park Podyjí
Bohumil Suchý, Entrepreneur
Jaromír Míčka, The Director of Environmental Department, Znojmo Municipal Authority
Zuzana Keyzlarová, ECOLAB Znojmo
Sandra Keyzlarová, Doctoral Student of Geography, born and living in Znojmo
Vladimír Herber, Senior Lecturer of Geography at Masaryk University
Petra Veselá, Master's Student of Geography, born and living in Znojmo

Marcela Mittnerová, Teacher at the Dr. Polesny Secondary-Grammar School in Znojmo
Andreas Sedlmayer, Administrative Director of the City of Retz
Norbert Silberbauer, Teacher at Gymnasium/Commercial Academy HAK in Retz
Brigitta Humpel, Chairman of the EFEU (Entwicklung-Friede-Eigenständigkeit-Umwelt/ Development-Peace-Autonomy-Environment)
Helene Schrolmberger, Municipal Counsellor for the Green Party Retz
Helmut Bergmann, Chairman of the Wine-Farmers Association Retz
Walter Fallheier, Municipal Counsellor (the environment portfolio)/Teacher
Hannes Weitschacker, Director of Retzer Land GmbH
Robert Brunner, Director of the National ark Thayatal
Sabine Schödelbauer, Deputy Director of Hotel Althof Retz

REGIONAL SECURITY AND INTERNATIONAL LEGAL REGULATION OF WATER PROTECTION AND USE – THE CASE OF SERBIA

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Abstract: The existing state of international legal regulation for the protection and use of waters, in the case of Serbia, raises various questions relevant to regional security. Firstly, analysis of the existing state of legal regulation shows that cooperation between Serbia and some neighbouring States is not adequately regulated. For instance, some bilateral agreements were concluded in the past on a basis which is not compatible with contemporary water management norms and standards. One important setback is the fact that Serbia lags behind other countries in the region when ratification of multilateral agreements is concerned. It should also be stressed that its existing water law, as well as institutional framework, do not, in some cases, meet standards of contemporary water management and that they need further improvement and harmonization with EU law.

Overall potential implications of this state of affairs on regional security could be viewed from different points. General aspects of regional security stem from the actual relations between countries of the region, and in the case of Serbia, especially with its neighbours. Specific aspects stem from relations concerning water management in the region, depending on the needs of the production sector and of the population.

The authors analyze relevant provisions of existing bilateral and multilateral treaties in the field of water management important for Serbia and for the region, as well as Serbian legal regulations. Special attention is paid to the present state in the field of legal regulation, as well as to the prospects of further improvement.

1. Introductory Remarks

It is possible to analyse the connection between regional security and the state of international legal regulation for the protection and use of water resources from different points of view and using different criteria. Basically, the question is asked how and to what extent international legal regulation influences regional security. In the existing literature such a question is most

S. Stec and B. Baraj (eds.), Energy and Environmental Challenges to Security,

often posed in the wider context of assessment where there is a possibility of potential conflicts concerning the common use of water resources shared by two or more States (Fathallah, 1999; Bogdanovic, 2007). Assessment of the efficiency of international law is measured by its ability to play a corrective role. It should improve international cooperation and prevent the above mentioned conflicts and, if they arise, resolve them. However, some are making efforts to radically change our concept of the interpretation of the role of international law in international relations, including environmental security issues (Handl, 1990).

The key thesis of this paper is that the existing system of international legal regulation for the protection and use of water resources is not adequate to the important role that water resources have or might have in relations between States. This applies to explicitly formulated links to questions of regional security, to the geographical coverage of certain regions and/or States, as well as to instruments developed by international law for fulfilling defined goals.

In this paper an effort has been made to shed light on the role and importance of international legal regulation for the protection and use of water resources, by analysing the situation in Serbia. The following three basic criteria have been taken into account: (1) Characteristics of the geographical position of Serbia in connection with the state of water resources especially having in mind Serbian dependence on transboundary watercourses, (2) The state of participation of Serbia in international agreements in the field of protection and use of international watercourses, as an indicator of participation in international cooperation in this field, and (3) The state of harmonization of national legal regulation in the field of protection and use of waters, and, primarily, harmonization with the relevant provisions of international water law and especially with the Helsinki Convention on the Protection and Use of Transboundary Watercourses and International Lakes (1992), as one of the basic sources of water law for the whole UNECE region.

Finally, special attention in this analysis has been paid to the provisions potentially concerning regional security in the three key multilateral agreements regulating the use and protection of waters.

2. International Treaties in the Field of Water and Regional Security

From a general point of view, many international treaties could have a certain importance for regional security.[1] Or, more precisely, the whole system of the existing treaties could be regarded as a part of the context of regional security. A more concrete analysis shows, however, that one of the key questions

[1] Here are not discussed other sources of international law (according to Article 38 of the Statute of ICJ) which could also be relevant to these issues.

that deserve our attention is the question concerning those provisions of certain international treaties which are more or less relevant for regional security. A preliminary question that should be considered is the definition of security, both in general and in a regional context, as precisely as possible, and the constituent elements of this notion (Todic, 1997; Stoett, 2005). Methodologically, the criteria of assessment of possible influences should be set first, which requires elaborated criteria. In a more meticulous analysis numerous provisions of certain international treaties relevant to regional security should be taken into account (the subject and goals of regulation, description and kind of polluters, sources of pollution, environment which is under protection, contents of rights and duties of various participants, terms for fulfilment of defined obligations, terms for fulfilment of duties and realization of rights, implementation control mechanisms of contracted obligations, consequences of non compliance with contracted obligations, resolution of disputes concerning interpretation and implementation of provisions of the treaty concerned, etc.).[2] There is no doubt that the impact of relevant provisions from the multitude of treaties in the field of environment and water resources[3] should be investigated not only in terms of the concrete effects each of them has but also in the context of synergy and mutual effects. For illustration, three of the most important treaties for Serbia could be mentioned: the Helsinki Convention on the Protection and Use of Transboundary Watercourses and International Lakes (1992), the Convention on Cooperation for the Protection and Sustainable Use of the Danube River (1994) and the Framework Agreement on the Sava River Basin (2002).[4] The Treaty on Pollution Protection of the Tisza River Waters and its Tributaries (1986) has not been implemented.

The Helsinki Convention on the Protection and Use of Transboundary Watercourses and International Lakes does not contain provisions explicitly mentioning regional security as one of the goals of the Convention.[5] It does

[2] For a general review of the international legal sources in the field of water see Sands (2003).

[3] See: Bilateral and Multilateral Agreements and other Arrangements in Europe and North America on the Protection and Use of Transboundary Waters, ECE/ENVWA/32, 1 June 1993; Addendum ECE/ENVWA/32/Add. 1, 23 January 1995; Addendum ECE/ENVWA/32/Add.2, 24 January 1996.

[4] Geographical and political reasons play an important role in the process of developing international water agreements. It is not necessary to specifically argue that there is a high level of interdependence between states due to the fact that more than half of all the river basins in the world are shared by two or more states. World Resources 1994–1995, *The Report by the World Resources Institute*, Oxford University Press, New York, 1994, pp. 182–183;

[5] Except in the Preamble in which "the Final Act of the Conference on Security and Cooperation in Europe (CSCE)" is mentioned. "National security" is mentioned Article 8 (protection of information), as a possible reason for refusal to publish information. Relations between "national", "regional" and other aspects of security is a special question which deserves separate analysis.

contain, however, a number of provisions which are more or less relevant to security. Such provisions are, for example, duties of Parties to improve cooperation as mentioned in the Preamble and Articles 1 (definitions),[6] 2 (general provisions relating to all parties), 3 (prevention, control and reduction), 4 (monitoring), 5 (research and development), 6 (exchange of information), 7 (responsibility and liability), 9 (bilateral and multilateral cooperation – provisions relating to the riparian parties), 10 (consultations), 11 (joint monitoring and assessment), 12 (common research and development), 13 (exchange of information between riparian states), 14 (warning and alarm system), 15 (mutual assistance), 16 (public information), etc. The Convention also contains provisions dealing with the settlement of disputes as well as concerning the interpretation and implementation of the Convention's provisions.

The Convention on Cooperation for the Protection and Sustainable Use of the Danube River (Danube River Protection Convention) also does not contain provisions explicitly mentioning regional security.[7] In Article 12, "national security" is mentioned in the context of the exchange of information, similarly as in the Helsinki Convention. In Article 14, which relates to "information to the public", the notion of "public security" is used, similar to the context of Article 12. Similarly to the Helsinki Convention the Danube River Protection Convention contains numerous provisions concerning the duty of States to cooperate: Preamble (four times), Article 2 (Objectives and principles of cooperation),[8] Article 4 (Forms of cooperation),[9] Part II

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[6]For example, the definition of "transboundary impact" as "any significant adverse effect on the environment resulting from a change in the conditions of transboundary waters caused by a human activity, the physical origin of which is situated wholly or in part within an area under the jurisdiction of a Party, within an area under the jurisdiction of another Party. Such effects on the environment include effects on human health and safety, flora, fauna, soil, air, water, climate, landscape and historical monuments or other physical structures or the interaction among these factors; they also include effects on the cultural heritage or socio-economic conditions resulting from alterations to those factors."

[7]On legal regulation concerning the Danube basin generally, see Bogdanovic, 2005.

[8]Article 2. "(1) The Contracting Parties shall strive at achieving *the goals of a sustainable and equitable water management*, including the conservation, improvement and the rational use of surface waters and ground water in the catchments area as far as possible. Moreover the Contracting Parties shall make all efforts to control the hazards originating from accidents involving substances hazardous to water, floods and ice hazards of the Danube River. Moreover they shall endeavour to contribute to reducing the pollution loads of the Black Sea from sources in the catchment area." (emphasis supplied).

[9]Article 4. "The forms of cooperation under this Convention as a rule are the following: (a) consultations and joint activities in the framework of the International Commission pursuant to the provisions of this Convention; (b) exchange of information on bi- and multilateral agreements, legal regulations and on measures in the field of water management; exchange of legal documents and directives and of other publications; other forms for the exchange of information and experiences."

(Multilateral cooperation), Article 5 (Prevention, control and reduction of transboundary impact), Article 6 (Specific water resources protection measures), Article 7 (Emission limitation: water quality objectives and criteria), Article 8 (Emission inventories, action programmes and progress reviews), Article 9 (Monitoring programmes), Article 10 (Obligations of reporting), Article 11 (Consultations), Article 12 (Exchange of information), Article 13 (Protection of information supplied), Article 14 (Information to the public), Article 15 (Research and development), Article 16 (Communication, warning and alarm systems, emergency plans), and Article 17 (Mutual assistance). Article 24 contains provisions concerning the settlement of disputes.

Similarly, as in the two conventions mentioned above, the Framework Agreement on the Sava River Basin (the Sava Agreement) does not contain provisions explicitly mentioning regional security, but it also contains numerous provisions concerning the duty of States sharing the water course to cooperate (Vukasovic, 2006). The duty to cooperate is mentioned in the preamble, in Article 2 (Objectives),[10] in the Second part (General principles of cooperation), and in Articles 3 (general obligation to cooperate), 4 (exchange of data information), 5 (cooperation with international organisations), 6 (cooperation with national organisations, authorities or bodies), 7 (principle of reasonable and equitable utilization of the waters) 8 (transboundary impact) 9 (no harm rule), 11 (sustainable water management), and 12 (Sava river basin management plan), and in Part IV – mechanism of cooperation (meeting of the parties, International Sava River Basin Commission, etc.). Resolution of disputes is prescribed by Articles 22 (general provisions), 23 (fact-finding expert committee) and 24 (role of the fact – finding expert committee).

There are many basic similarities between these three international treaties: sustainable water management and development as an objective, cooperation as a fundamental framework, commissions as a formal institution, joint principles of environmental policy (such as prevention, polluter pays, precautionary principle, etc.), instruments and fields of cooperation, exchange of information, consultations, public relations, monitoring, reporting, provisions on dispute settlements, etc. Besides that, the characteristics shared by all three

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[10] Article 2. "1) The Parties shall cooperate in order to achieve the following goals: a) Establishment of an international regime of navigation on the Sava River and its navigable tributaries; b) Establishment of sustainable water management; and c) Undertaking of measures to prevent or limit hazards, and reduce and eliminate adverse consequences, including those from floods, ice hazards, droughts and incidents involving substances hazardous to water. 2) For the purpose of carrying out the goals stated in Paragraph 1 of this Article, the Parties shall cooperate in the process of the creation and realization of joint plans and development programs of the Sava River Basin and harmonization of their legislation with EU legislation."

of the international treaties is an intention to regulate in a more precise way the duties of states concerning necessary internal measures thus establishing the concrete link between international and national law. Although different modalities of such formulations could be discussed, as well as their effects in practice, there is no doubt that national legal regulation in such a way becomes increasingly directly linked to international treaties.

3. The State of Water Resources of the Republic of Serbia

There are numerous determinants which, in the case of Serbia, limit or enhance its participation in international cooperation (geographical position, level of economic development, characteristics of economic structure, state of particular sectoral policies and strategies,[11] characteristics of historical development, characteristics of political, legal and economic systems, functioning of legal state, citizen's position in society, international position of the country, state of membership in certain international organisations, state of the environment, environmental awareness, institutional build up in the water, energy and environmental fields, consequences of the crises in former Yugoslavia during the last decade of the 20th century, consequences of the NATO intervention in 1999, etc.)[12].

The state of water resources in Serbia should be viewed in the context of the state of the environment in general.[13] Serbia is moderately poor where water resources are concerned. According to the basic document for water management,[14] the whole territory of Serbia has a flow of national waters of

[11] For example, the National Defense Strategy contains provisions relating to the role of the military in providing assistance in case of natural disaster or catastrophes of a large scale, when human life, environment and material goods are in danger. See www.mod.gov.yu/02ministarstvo/04-odredbe/0413-strategija-s.htm

[12] *The Kosovo Conflict – Consequences for the Environment & Human Settlements*, UNEP, UNCHS, Nairobi, 1999; From Conflict to Sustainable Development – Assessment and Clean-up in Serbia and Montenegro, UNEP, 2004; *Posledice NATO bombardovanja na životnu sredinu SR Jugoslavije - Izveštaj SRJ* (Consequences of the bombing on the environment – Report of the SR Yugoslavia), Beograd, Savezno ministarstvo za razvoj, nauku i životnu sredinu, 2000.

[13] See *Izveštaj o stanju životne sredine u Republici Srbiji za 2006. godinu* (The state of the environment report for 2006), Ministarstvo zaštite životne sredine, Agencija za zaštitu životne sredine, Belgrade, 2007, pp. 73–95.

[14] See, *Vodoprivredna osnova Republike Srbije* (Water management basics of the Republic of Serbia), Ministry for agriculture, forestry and water, Institute for water management, "Jaroslav Cerni", Belgrade, 2001, pp. 14–56.

16 billion cubic meters per annum, or, on average, 1,600 m^3 per citizen (it is believed that a country has enough of its own water if the flow is more than 3,000 m^3 per capita annually). From this data it is possible to conclude that domestic waters are not sufficient in Serbia and that the country must count on transitional waters. The state of water resources in some parts of Serbia is even worse because of unequal distribution. There are regions in the country, most often populated lowland regions, where the domestic water flow is much lower than the average (Vojvodina, Pomoravlje, Kolubara, Sumadija, Kosovo, South Serbia), with cases of less than 500 m^3 yearly water flow per capita (six times less than the needed 3,000 m^3). So, water must be imported from other parts of the country or taken from transitional waters.

Transit waters, which flow to Serbia from other countries or, according to the definition from the Helsinki Convention – transboundary waters – are of considerable quantity (above 5,000 m^3/s, or ten times more abundant than domestic). Their use is necessary for a positive water balance of Serbia, and they are supposed to be cleaner in future.

Serbia borders eight countries: Albania, Bosnia and Herzegovina, Bulgaria, Montenegro, Croatia, Hungary, Former Yugoslav Republic of Macedonia and Romania. Almost all water courses on Serbian territory, except some tributaries of the Danube (Velika Morava, Mlava, Pek) and Sava (Kolubara) belong to the category of transboundary surface waters.

Transboundary rivers belong to the catchment areas of the Black Sea, Adriatic, and Aegean Sea, the Black Sea being dominant (92% of the territory of Serbia). In almost all transboundary water courses Serbia is a downstream riparian country, except in the cases of Beli Drim, Timok and Dragovištica. In the case of the Danube River it is both downstream and upstream.[15]

Important underground transboundary waters are shared with Romania and Hungary (in Banat and Backa) and with Croatia (in Srem). Water extraction in most parts of Vojvodina is oriented towards these underground waters, and there are problems of over-extraction of them and of their poor quality.

Where energy is concerned, it should be stressed that the most important renewable energy resource is hydroelectric potential (ca. 17,000 GWh), from which today about 10,000 GWh is in production. So, the total remaining technically usable hydroelectric potential of Serbia is about 7,000 GWh, and that amounts to 8.6% of total energy consumption in 2003. The remaining potential for construction of bigger electric plants (above 10 MW) is mainly

[15] See, *National Programme for Environmental Protection (proposal)*, Government of the Republic of Serbia, Environmental Capacity Building Programme 2003, Belgrade, 2007, p. 27. Also, http://www.ekoserb.sr.gov.yu/dokumenti/razno/NACIONALNI%20PROGRAM%20ZASTITE%20ZIVOTNE%20SREDINE.pdf. Accessed 7 September 2007.

in the Morava (2,300 GWh), Drina and Lim (1,900 GWh) and Danube (1,000 GWh) catchment areas, which in total could yield an annual production of about 5,200 GWh. There are around 900 potential locations on Serbian rivers where small electric plants (under 10 MW) could be built, with a possible annual production of about 1,800 GWh. When practical possibilities for building hydroelectric plants are considered, it must be kept in mind that non-energy criteria play an important role – for example, the use of waters for other purposes, agreements with neighbouring countries, etc.[16]

4. Status of Serbia in Relevant International Treaties[17]

The most general characteristic of the status of Serbia in relevant international treaties is the fact that it is lagging behind other countries of the region. This is usually explained as a result of its past legacy, the crisis in the 1990s, international sanctions,[18] etc. Besides formal participation in international treaties, more important is the question of their interpretation and implementation, but that is not the topic of this paper.[19]

(a) Of the treaties to which Serbia is a Contracting Party, probably the most important are the following: Treaty on Fishery in the Danube River Waters between Government of FNRJ, Peoples Republic of Bulgaria, Romanian Peoples Republic, and USSR (1958), Convention on Wetlands of International Importance Especially as Water Fowl Habitat (1971), International Convention for Compensation for Oil Pollution Damage (1971), Convention Concerning the Protection of the World Cultural and Natural Heritage (1972), Convention on Long-range Transboundary Air Pollution (1979), Protocol to the 1979 Convention on Long Range Transboundary Air Pollution on Financing of the Co-operative Programme for Monitoring and Evaluation of the Long-range Transmission of Air

[16] See, *Strategija razvoja energetike Republike Srbije* (Strategy of developent of energy production in Serbia), www.srbija.sr.gov.yu/vest/dokumenti sekcija.php?id = 4567, p. 7. Accessed 16 September 2007.

[17] Ratification of the relevant international treaties could be used, at least, as a simple indicator for demonstrating implementation of legal obligations. *Implementation of UNECE multilateral environmental agreements*, ECE/Belgrade.Conf/2007/12, p. 3.

[18] International legal aspect of the Yugoslav crisis and NATO intervention is not discussed in this paper. See, Todič, D. (1998), pp. 40–55.

[19] See the review of the state of implementation of MEAs in the FR Yugoslavia in: Todic, D., *Medjunarodne konvencije u oblasti zivotne sredine i SR Jugoslavija* (International conventions in the field of environment and FR Yugoslavia), REC, Belgrade, 2002; For other states of the region, see the analysis in www.rec.org/REC/Programs/REReP/AIMS/outputs.html. Accessed 22 September 2007.

Pollutants in Europe – EMEP (1984), The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989), UN Framework Convention on Climate Change (1992), Treaty between the Federal Government of FRY and Government of the Russian Federation on Cooperation on Environmental Protection (1996), Convention on Biological Diversity (1992), Convention on Environmental Impact Assessment in a Trans-boundary Context (1992), Convention on Co-operation for the Protection and Sustainable Use of the Danube River (1994), Framework Agreement on the River Sava (2002), Framework Convention on the Protection and Sustainable Development of the Carpathians (2003).

Recently, the Serbian Parliament ratified the following international treaties: United Nations Convention to Combat Desertification in Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa, Convention on the Conservation of European Wildlife and Natural Habitats, Convention on the Conservation of Migratory Species of Wild Animals, Convention on Environmental Impact Assessment in a Transboundary Context, Framework Convention on the Protection and Sustainable Development of the Carpathians.[20]

As it is obvious from the given list, Serbia did not ratify the Helsinki Convention on the Protection and Use of Transboundary Watercourses and International Lakes, the treaty of key importance.[21] Besides that, when one makes conclusions concerning the position of Serbia's international cooperation in the use and protection of waters, one should take into account the status of other countries in important international treaties. This is especially important when neighbouring countries are in question. So, for example, the neighbouring contracting parties of the Helsinki Convention on the Protection and Use of Transboundary Watercourses and International Lakes are: Albania (1994), Croatia (1996), Hungary (1994), Bulgaria (2003) and Romania (1995). Bosnia and Herzegovina and FYR Macedonia are not Parties to the Convention.

(b) Besides the mentioned multilateral treaties, there are several bilateral agreements with neighbouring states which regulate cooperation concerning waters. They are: Agreement between the Government of FPRY and

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[20] All published in "Off. J. RS", No. 102/07.

[21] Serbia is not a member of several other multilateral environmental agreements such as the Convention on the Transboundary Effects of Industrial Accidents (Helsinki, 1992), Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus, 1998), Convention on Prior Informed Consent for Certain Hazardous Chemicals and Pesticides in International Trade (Rotterdam, 1998), Convention on Persistent Organic Pollutants – POPs (Stockholm, 2001), as well as protocols to the relevant agreements.

PR of Hungary on water management issues (1955), Agreement between the Government of FPRY and PR of Hungary on fishery in boundary waters (1957), Agreement between the Government of FPRY and PR of Hungary on water transport on River Tisza (1959), Agreement between the Government of FPRY and PR of Bulgaria on water management issues (1958), Agreement between the Government of FPRY and PR of Bulgaria on fishery in boundary waters (1962), Agreement between the Government of FPRY and PR of Romania on hydroelectric questions on hydroelectric systems and water courses along the boundary or cut by boundary (1955), Agreement between the Government of FPRY and PR of Romania on fishery in boundary waters (1961), Agreement between the Government of FPRY and PR of Romania on building an exploitation of the hydroelectric and navigation system Dzerdap (1963, 1964, 1967, 1976, 1977, 1987, 1998).

Several international bilateral agreements, concerning water use and protection, are in the process of being prepared. Of special importance for Serbia are agreements with neighbouring countries (Croatia, Romania, Bulgaria, Bosnia and Herzegovina, etc.).[22] It should be added that some of the existing bilateral agreements have been inherited from the Former Yugoslavia and that they are rather obsolete and not in accord with contemporary tendencies in the field of water resources management.

(c) The Treaty establishing the South East European Energy Community (2005) is one of most important international agreements to which Serbia has recently become a party, both in fields of energy (electricity and natural gas) and environmental protection.[23] This document contains a number of measures concerning the efficient management of energy systems, environmental protection, and use of alternative sources of energy. It is important to stress that the EU *acquis communautaire* is applied both in energy and environmental fields and that the countries of South Eastern Europe, including Serbia, have in such a way directly been linked to the EU in two important fields.

There is no doubt that the system established by the above-mentioned treaty is of immense importance for regional and European cooperation in the fields of energy and environmental protection in general and for environmental

[22] The Agreement between Serbia (FR Yugoslavia) and FYR Macedonia on environmental protection has been signed but it still has not been ratified.

[23] Off. J. RS, No. 62/06. Parties of the Treaty are: European Community, Albania, Bulgaria, Bosnia and Herzegovina, Croatia, The Former Yugoslav Republic of Macedonia, Montenegro, Romania, Serbia and The UN Interim Administration Mission in Kosovo.

and energy security in particular.[24] Of special importance is the introduced mechanism for the settlement of disputes and potential conflicts (and thus security issues), as well as provisions concerning the prospects of further improvement of cooperation between contracting Parties and the EU.[25]

5. National Legal Regulation

Although the Constitution of the Republic of Serbia provides for the right to a healthy environment as one of the basic rights of every citizen, it is very hard to explain the implications of this general provision in actual practice.[26]

When national legal regulation relevant for the implementation of international treaties is analysed, it is important to keep in mind the existing state of the regulation as well as the activities aimed at the harmonization of national regulations with international standards (Vukasovic and Todic, 2002; Vukasovic, 2005). One of the most important characteristics of the present state of the legal system of Serbia as a whole, is the process of transition towards international standards in general and especially towards harmonization with EU standards. This general remark applies to legal regulation concerning waters, energy and environment, and one should, when analyzing the relevant law, always keep in mind that these three fields are in the process of intensive transformation, through both the adoption and the amendment of new legislation. The best example of this is the new Law on Water, which has been under preparation for quite a considerable time, and which will be

[24] See Article 2. "The task of the Energy Community shall be to organize the relations between the Parties and create a legal and economic framework in relation to Network Energy, as defined in paragraph 2, in order to: (a) create a stable regulatory and market framework capable of attracting investment in gas networks, power generation, and transmission and distribution networks, so that all Parties have access to the stable and continuous energy supply that is essential for economic development and social stability, (b) create a single regulatory space for trade in Network Energy that is necessary to match the geographic extent of the concerned product markets, (c) enhance the security of supply of the single regulatory space by providing a stable investment climate in which connections to Caspian, North African and Middle East gas reserves can be developed, and indigenous sources of energy such as natural gas, coal and hydropower can be exploited, (d) improve the environmental situation in relation to Network Energy and related energy efficiency, foster the use of renewable energy, and set out the conditions for energy trade in the single regulatory space."

[25] Title VII – Implementation of decisions and dispute settlement, Art. 89–93.

[26] Off. J. RS, No. 98/06, Art. 74. "Everyone shall have the right to healthy environment and the right to timely and full information about the state of environment. Everyone, especially the Republic of Serbia and autonomous provinces, shall be accountable for the protection of environment. Everyone shall be obliged to preserve and improve the environment."

the basis for a number of important sub-legal acts.[27] Besides this law, several other legal acts are expected to be adopted in the near future.[28]

(a) A part of the existing Serbian legal regulation concerning waters is obsolete, has many legal lacunae, is not well harmonised conceptually, is not efficiently harmonised with other relevant sectors, etc.[29] According to the National Sustainable Development Strategy, problems in the water sector are related to the lack of sufficient planning for implementation of the EU Water Framework Directive, insufficient institutional and other capacities, inadequate funding of water management, low price for water and services and lack of economic incentives, lack of harmonization in sectoral policies with other sectors, insufficient percentage of connection to public systems of water supply, lack of rational use of water and bad quality of water in certain areas, bad quality of water in certain watercourses, and insufficient protection of water quality.[30]

(b) The basic legal act regulating energy production and consumption is the Law on energy (Off. J. RS, No. 84/04), which is believed to be mostly harmonised with contemporary trends in this field. But, where energy is concerned, other acts must be taken into account which still need harmonisation, for example the Law on mining (Off. J. RS, No. 44/95, 85/05), the Law on forestry (Off. J.. RS, No. 46/91, 83/92, 54/93, 60/93, 53/93, 67/93, 48/94, 54/96), as well as some sub legal acts.

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[27] The adoption of a new Law on Water and other laws and relevant by-laws to ensure harmonization with the EU Water Framework Directive is a priority. The need for introducing a regulatory function in the water sector is most prevalent in the field of providing public water supply and sewage services … A separate action plan needs to be developed for the construction of waste water treatment plants, after establishing an inventory (register) of polluters and after adopting regulations and standards. … Other planned documents include the Water Policy of the Republic of Serbia, water management plans, the Plan for Development of the Water Sector, and the strategy for development and use of geologic resources of Serbia, within which there is a section relevant to hydrologic surveying of ground waters." National Sustainable Development Strategy (draft), Belgrade, september 2007, p. 66, See also, http://www.odrzivi-razvoj.sr.gov.yu/assets/download/STRATEGIJA_ODRZIVOG_RAZVOJA_IV_NACRT.pdf. Accessed 2 September 2007.

[28] For example, Law on the amendment of the law on energy, Law on waste management, Law on nature protection, Law on air protection, Law on packaging and packaging waste, Law on protection from ionizing radiation, Law on protection from nonionizing radiation and on nuclear safety, Law on food safety, etc.

[29] For general comments of this problem see: D. Caponera (2001) The Inadequacy of Water Resources Legislation, Juridical life, Belgrade, No. 12/2001, pp. 447–452.

[30] National Sustainable Development Strategy (draft), op. cit., p. 66.

(c) Environmental protection is regulated through a considerable number of legal and sub legal acts. The most important are those adopted recently because a serious effort has been made to harmonise them with international standards. Four basic legal acts in the field of environmental protection important for water use and protection as well as for the impact of energy production and consumption on the environment were adopted in 2004. They are: the Law on environmental protection, Law on environmental impact assessment, Law on strategic environmental impact assessment, and the Law on integrated pollution prevention and control.[31] On the basis of these laws, a number of sub legal acts have been adopted. However, numerous other environmental legal regulations are expected to be adopted and some of them are directly relevant for implementation of international treaties.

(d) Other groupings of regulations of the Republic of Serbia which are relevant for ratification and implementation of international treaties could be formed on the basis of different criteria. Accordingly, one should be open to other possible approaches. Aside from the regulation in the domain of state administration, in this category the following regulations could be mentioned: Law on concessions, Law on local self-government, Law on foreign investments, Law on planning and construction, Law on spatial plan of the Republic of Serbia, Law on elementary disasters, Law on public enterprises, Law on public procurement, Law on agricultural land, etc.[32]

6. Conclusions and Proposals

Existing international treaties and mechanisms of cooperation, to which Serbia is a contracting party do not cover adequately all geographical sub regions to which it belongs (Danube, Sava, Carpathians, Black Sea, Southeast Europe, etc.). It should be added that Serbia has not concluded bilateral water agreements with neighbouring countries, which could be, in unfavourable circumstances, a challenge for regional security. There is also the need for an introduction of new specific instruments of cooperation in Southeast Europe.

1. Three of the most important international treaties for Serbia do not contain explicit provisions concerning regional security, but contain different

[31] All laws have been published at the same issue of the Off. J. Republic of Serbia (Off. J. RS, No. 135/04).

[32] A more detailed analysis should also take into account regulations concerning procedural matters dealing with the adoption of international treaties where problems could be faced in coordination between relevant stakeholders.

provisions which are of direct importance to regional security and which should be interpreted in such a way. Accordingly, one of the basic criteria for assessing the state of regional security should be the level and quality of interstate cooperation on sustainable water management in the region. The abovementioned international treaties contain precisely described and elaborated forms of cooperation that should be understood as a prerequisite as well as a mechanism for strengthening regional security. However, they do not adequately recognize the specific capabilities of the potential members.

2. Certain controversies about the position of Serbia stem from the imbalance between a high dependence on transboundary watercourses (which should be an incentive for more intensive participation in international cooperation in general and in different forms of international cooperation based on international treaties in particular) and the present state of participation in international treaties, which is still unsatisfactory 7 years after the normalisation of relations with the international community. The fact that Serbia has not concluded bilateral water agreements with neighbouring countries (which would be based on contemporary principles of water management and protection) could be, in unfavourable circumstances, a challenge for regional security. The relations between "national security" and "regional security" and the nature of this challenge are, however, not easy to assess and quantify.
3. There is no doubt that the unsatisfactory participation of Serbia in international treaties could be an obstacle for normal cooperation. The fact that Serbia does not have bilateral agreements concerning the use and protection of waters based on contemporary principles of water management with neighbouring countries certainly does not contribute to regional security.
4. From the fact that the existing international treaties concerning water use and protection are not sufficiently applied in Serbia, and especially from the fact that Serbia is still not a party to the Helsinki Convention, it could be concluded that the contemporary system of legal regulation of water use and protection in Serbia cannot function properly and that it needs further improvement. The fact that legal regulation of water use and protection in a country is still not harmonised with EU legal regulation and with international treaties can cause problems in the functioning of the system as a whole, thus influencing negatively regional security.
5. Existing international treaties and mechanisms of cooperation do not cover adequately all geographical sub regions to which Serbia belongs (Danube, Sava, Carpathians, Black Sea, Southeast Europe, etc.). As a result, there is the need for an introduction of new specific instruments of cooperation in Southeast Europe. A regional agreement for South Eastern Europe should

be concluded and supported – which would then regulate international cooperation in the field of environmental protection within the context of improvement of regional security.

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THE INTERNATIONAL COMMUNITY'S APPROACH TO ENVIRONMENTAL SECURITY CHALLENGES

INTERNATIONAL ORGANIZATIONS' CO-OPERATION AROUND ENVIRONMENT AND SECURITY

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Abstract: A number of international organisations, including several UN programmes, the OSCE, REC and NATO have collaborated on the Environment and Security (ENVSEC) initiative which assesses environmental and security linkages in a number of regions, such as South Eastern Europe, Central Asia, and Eastern Europe. This paper looks at the institutional characteristics which have been instrumental in the development of the Environment and Security initiative – including participation, decision-making, and the role of the secretariat. Further factors influencing the co-operation within the Environment and Security initiative are examined, such as donor interactions, the increased profile of security, and particularly the development and bonds of friendship at lower and middle managerial levels. Finally, these characteristics are viewed in the context of roles of international organisations in conflict resolution, peace building and peace keeping.

Keywords: Observation, mapping, resource distribution, environmental change, economic transition, environment, peace operations, peace maintenance, conflict resolution, international relations, capacity building, peacekeeping practices, peace building initiative, human security, reconciliation

1. Introduction

The end of the Cold War, the break up of the Soviet Union, and the democratic transition of many socialist states during the late 1980s and 1990s marked an era of upheaval in the security field (Peck, 1998). Out of this theoretical turmoil emerged new concepts and ideas on how we consider security, the state, human development, human rights, and the pursuit of peace (Khagram et al., 2003). Concepts such as human security, incorporating freedom from fear with freedom from want, preventative diplomacy as a core mandate of the UN and the OSCE, and the links between the environment and security, were all presented, debated, and over time incorporated into international organisations as principles, plans and programmes. One such initiative is the Environment and Security initiative (ENVSEC), a joint programme of the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), the United Nations Economic Commission for Europe (UNECE), The Regional Environmental Center for Central and Eastern Europe (REC), the Organisation for Security and Co-operation in Europe (OSCE) and the North Atlantic Treaty Organisation (NATO) (associate member).

This paper discusses the various practicalities involved in the co-operation of international organisations around environment and security issues as experienced by the above organisations through their co-operation in the ENVSEC initiative. The research carried out for this paper highlighted the various approaches to assessing environment and security linkages, the methods developed to assess these links, and the role of co-operation around environment and security in the conflict prevention and mitigation process.

The research also highlighted a number of factors which were instrumental in the creation and success of ENVSEC including the role of donors, high level management and relationships between mid and lower level management. These factors were all important in overcoming the various institutional barriers which may develop to prevent successful co-operation between international organisations.

Finally, the role of international organisations linking environment and security is considered in the context of conflict resolution and peace building.

2. Methods

The findings of this research are based on a period of 5 month participant observation within the ENVSEC team, based in Bratislava and Geneva. Participant Observation was also conducted at a number of ENVSEC meetings, including informal team meetings, advisory board meetings, and secretariat meetings. In depth semi structured interviews were conducted with 26 individuals, all of whom had experience with ENVSEC. Documents pertaining to the ENVSEC initiative were also analysed.

Key for interviewees

Interviewee position	Individual code
Donor	D1
Donor	D2
Donor	D3
Donor	D4
Donor	D5
National Focal Point	NFP1
National Focal Point	NFP2
National Focal Point	NFP3
National Focal Point	NFP4
Expert	E1
Expert	E2
Partner (non partner)	NP1
Partner (non partner)	NP2
Partner	P1
Partner	P2
Partner	P3
Partner	P4
Partner	P5
Partner	P6
Partner	P7
Partner	P8
Partner	P9
Partner	P10
Partner	P11
Partner	P12
Partner	P13
Partner	P14

3. What is ENVSEC?

ENVSEC is a programme set up to assess links between the environment and security in a number of regions including Central Asia, Southern Caucasus, the Balkans, and Eastern Europe. The basic structure of the ENVSEC initiative is as follows (Figure 1).

The methods used by ENVSEC to carry out its assessments include regional assessments conducted by a collection of experts including regional experts. These assessments result in a desk study which forms the basis for regional stakeholder meetings which agree on the content of the regional assessment. The stakeholder meetings also involve mapping sessions whereby GIS is used to create regional maps highlighting issues and areas where environmental problems influence security, or are a possible source for trans-boundary co-operation.

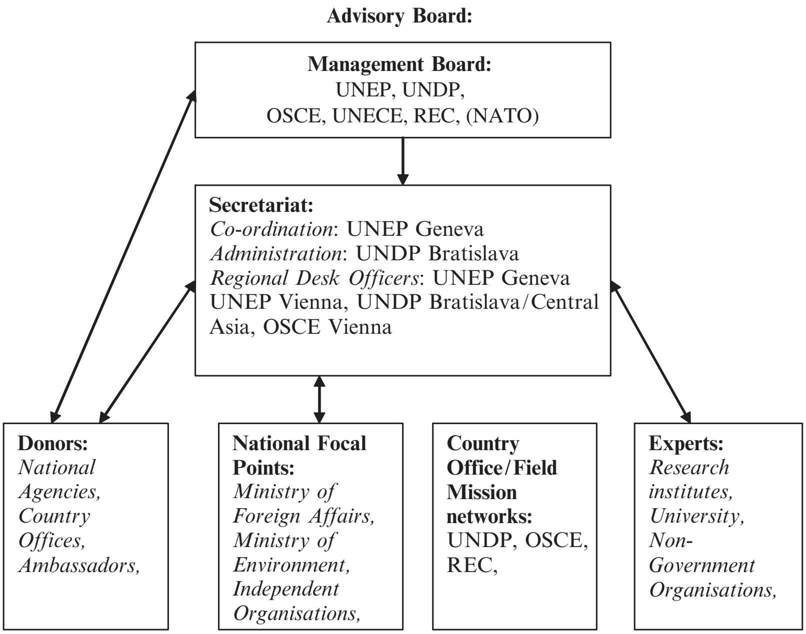

Figure 1. Structure of the ENVSEC initiative.

ENVSEC adopts a regional approach to environment and security assessment, with subsequent more localised or topical assessments possible. Other possible approaches to assessments include ecosystem based assessments.

Mapping has arisen as one of the key defining methods of the ENVSEC initiative. The use of mapping by the initiative has many antecedents. Primarily, there is an institutional interest and capacity for mapping through Grid Arendal, a driving partner of the initiative. Other reasons for the subsequent success of the maps include the marketability of the simple and easily understood maps for decision makers and donors. The maps also represent a common language among various sectors with little common experience, for example Ministries of Environment and Ministries of Foreign Affairs. The final maps and assessments include a list of regional priorities which have been agreed upon by the stakeholders.

Once the maps and regional assessments have been approved by the governments of the states involved, they are published and used in several ways to target the development of projects in the regions.

The first way projects are developed is directly by the partner organisations using the list of priorities agreed on during the assessment phase. The second way is when a new partner organisation joins the initiative, and here the initiative selects projects or programmes which fit with the priorities and adds them to the ENVSEC portfolio, the third method is the approach taken by NATO, which uses the priorities from the assessment to develop projects which are then carried out separately from the ENVSEC portfolio.

This process has resulted in the following list of priorities being developed for the region (Table 1). The priorities have identified the following links between the environment and security:

- Resource distribution – linked to the Homer-Dixsonian view of resource scarcity, capture and marginalisation
- Environmental mismanagement – such as pollution and poor planning
- Vulnerability to environmental change related to human security
- Poor governance – including a lack of legal instruments at the national and regional level to protect against environmental harms or deal with them if they arise
- Economic transition – the results of economic transition on investment in industry and infrastructure, and on the question of land tenure
- Effects of conflict on the environment – land mines, depleted uranium, munitions dumps

4. Main Findings

4.1. INSTITUTIONAL ANALYSIS

Through investigating and analysing the institutional arrangements between the organisations involved in the ENVSEC initiative including: the material conditions, attributes of the community (culture, norms, behaviour) rules in use, action areas and action situations (decision making processes and locations), patterns of behaviour and outcomes achieved – the following observations were made about the institutional features of the ENVSEC initiative.

Further to the features identified in Table 2, a number of important institutional features were also observed. Fundamental norms of the community included the principle of sovereignty, the link between environment and security in a general sense, loyalty to one's organisation, commitment to ENVSEC, but also a certain level of confusion on the part of the donor representatives and national focal points from participating states.

5. Partner Co-operation

In addition to the above institutional features, a number of other factors emerged as being instrumental in the co-operation between the partner

TABLE 1. Regional priorities and environment and security links.

Report	Priorities	Environment and security link
Central Asia and South Eastern Europe	Water and ground water pollution, availability and distribution, affected by energy generation, agriculture production and leakage from hazardous waste dumps, and impacting on economic development and public health	Resource distribution, scarcity due to mismanagement
	The legacies of conflict and of the ageing of industrial and power generation developments, impacting negatively on human health through trans-boundary air and water pollution	Effect of conflict on the environment. Effect of mismanagement on the environment
	Land degradation through over-use of pesticides and fertilisers, desertification, salinity and wind erosion, often resulting in population migration or displacement	Vulnerability to environmental change, effect of mismanagement on environment
	Depletion of natural resources – deforestation and erosion in mountain areas, impact on well-being caused by migration and poverty	Resource distribution, vulnerability to environmental change
	Direct legacies of previous conflicts, including migration, and the foreclosure of contamination of lands and water bodies due to land mines, depleted uranium and unexploded ordnance. Conflicts have displaced peoples across South Eastern Europe and Tajikistan. In the wake of conflicts, the return of refugees is generating local tensions related to contested ownership of land, as records are incomplete or non-existent, and ethnic and historical anger simmers beneath the surface	Effect of conflict on the environment
	Policy failure and lack of financial means to maintain ageing industrial sites, to repair and upgrade sewage, water and air treatment facilities, and to ensure the safe disposal of waste and harmful chemicals. Each poses serious threats to the health and safety of people in the regions	Lack of good governance, economic transition
	Environmental disasters (landslides and earthquakes) including human-induced ones and their potential interaction with other risks impacting on migration	Vulnerably to environmental change
Ferghana Valley	Ineffective interstate agreements on water-sharing due to lack of political will. Breakdown in communal services, limited state resources to repair infrastructure	Lack of good governance, economic transition

	Downstream countries highly dependent on upstream ones for water supply. Water and land are strategic resources both for states (cotton as a source of hard currency) and sub national areas (increased importance of agriculture for survival)	Resource distribution
	Syr-Darya basin – shared river basins	Resource distribution
	Polluted and waste hotspots and areas, waterlogged areas, degradation of land and forests	Environmental mismanagement, vulnerability to environmental change
	Poor radioactive waste management and risk of trans-boundary pollution	Environmental mismanagement
	Industrial pollution and chemical risk	Environmental mismanagement
Southern Caucasus	Mines and industrial activities	Environmental mismanagement
	Water issues – pollution, poorly maintained dams, coastal erosion	Environmental mismanagement, poor governance, economic transition
	Land degradation – soil pollution and erosion, use of pesticides, heavy metal contamination	Environmental mismanagement, vulnerability to environmental change
	Security issues – areas of frozen conflict, ethnic and political tension, nuclear waste, munitions dumps, refugee camps and settlements	Effect of conflict on environment/ social issues
	Transport and communications – transport routes, oil pipeline routes	Resource distribution
Eastern Europe	Pollution, use and development of shared resources	Environmental mismanagement, resource distribution
	Toxic waste including stockpiles of obsolete and banned pesticides	Environmental mismanagement, poor governance
	Risk of cross-border environmental impact of industrial accidents	Environmental mismanagement, poor governance, vulnerability to environmental change
	Environmental impacts of energy sources and infrastructure	Environmental mismanagement, poor governance
	Pollution and risk of accidents related to past and current defence activities	Environmental mismanagement, poor governance

TABLE 2. Institutional features of the ENVSEC initiative (Wettestad, 2001).

Institutional feature	ENVSEC characteristics
Access and participation procedures	Inclusive – governments, donors, experts, NGOs all meet within the advisory board. However, access and participation to decision-making processes and bodies is exclusive, with partner organisations and governments alone involved. Inclusive institutions are considered to lead to effective decision making as all positions are represented and legitimacy is high, however, exclusive institutions allow for delicate negotiations and the reaching of compromise.
Decision-making rules	Consensual decision-making (rather than majority voting) at the secretariat, management board and the regional assessment level. Consensual decision making also allows for negotiation and compromise which provides legitimacy for decisions, however, it can slow processes down and give power to 'laggards' (Wettestad, 2001).
Role of the secretariat	Active, entrepreneurial secretariat (rather than stage hand management), involved in devising tangible solutions to problems. The secretariat acts as the process driving force.
Structuring the agenda	Agenda setting is ad hoc and very comprehensive which leads to problems of focus and scope; this also allows for package solutions to over arching problems. However, comprehensive agendas create more opportunities for deadlock.
Organisation of the science-politics interface	Emphasises national control rather than scientific independence and integrity – this allows the information available to be highly relevant to the political and decision-making arena.
Verification and compliance mechanisms	There are no verification and compliance mechanisms set up at present to check the progress of information to parties, or the effectiveness of the initiative.

organisations. These included the individual mandate of the organisation, the level of understanding of the other partner organisations, the ability of individuals to change their modes of operation within partner organisations, the management of resources (time and money), and the approach to fund raising.

The main factors involved in creating and sustaining the co-operation between ENVSEC partners includes:

- Donor call for international organisation co-operation
- High level demand for inclusion of security in all sectors
- High degree of operational overlap between regional and country office of international organisations
- Trust and friendship developed between middle and low management

5.1. MANDATE OF ORGANISATIONS

One major difference between the organisations is their mandate. Regardless of mission creep, or misunderstandings of role, the partner organisations have set mandates. While all the main partners included in this study (REC and UNECE became full partners at the end of the study period and so are not reviewed in depth) are primarily security organisations, the structure, decision-making processes, funding and relationships with states are very different. These differences are expressed by individuals who represent the organisations:

> Organisations have different mandates and interests and different forces at work. For example the OSCE has been very concerned about what scope should be. UNEP wants to put Aarhus initiative under the Environmental Security umbrella, also perhaps some people within OSCE question this.
>
> We have different institutional mandates, each of those different mandates gives us a comparative advantage and we try to each work to add value from our comparative advantage, UNEP has environmental expertise, Frits is extremely well connected with a number of donors in Europe and Canada and there's a lot of environmental firepower in the regional office for Europe. OSCE has its delegations, direct contact links to bilateral donors that fund a lot of ENVSEC things and then they have missions in the field. We [UNDP sic] have the overall development perspective, we have the country office network that is most developed in all of the countries we are working in, whereas OSCE can link environment and security very nicely, we can link environment and development very nicely. So, everyone understands that, and everyone sees that this makes sense for those reasons (P7).

From the genesis of ENVSEC, the approach taken by the individuals involved has been to look at the areas or expertise and strengths each separate organisation can bring to looking at environment and security issues strategically; they refer to this as 'value added'. This means that there are some differences in how different organisations approach projects:

> OSCE has a project called 'Melange' which turns rocket fuel into fertiliser. UNDP would either not do it, or do it differently, we would develop capacity, install the skills to convert the rocket fuel. In Prespa Park there is a project to reduce the use of pesticides, we try to do that by building capacity of the government agriculture extension services and also build farmers associations and link this to EU markets. So, once we've left, these associations should be self-sustainable. Once you get the ball rolling it should continue (P6).
>
> We basically ruthlessly went through the comparative advantages of each of the organisations saying what do you have to offer, UNEP, what does OSCE have to offer and the same goes for UNDP. So we came at the end to the conclusion that perhaps we can create some initiative by which the work of these three organisations can be inter linked that this can also be some kind of an example of how the UN systems can work together (NP1).

Donors and participating countries are aware of these different mandates, and this creates legitimacy for ENVSEC, as it is seen as a process through which the international organisations can work strategically around issues regardless of mandate:

> ENVSEC is an unique opportunity for organisations with different mandates to operate in a policy field where environment and human security are closely related (D2).

The difference in mandate does not stop at the organisational level, but some also see it as an issue between regional centres and country offices (specifically within UNDP):

> the Regional Office of UNDP has a different mandate than country offices – it's more oriented towards policy advice etc and they have more time for that – more time to understand problems and think about solutions – less focus on delivery of projects and resource mobilisation – Bratislava was set up mainly to create a regional centre of knowledge which country offices could use for their programmes and get knowledge, the mandate of Bratislava started to shift – like the Regional Programme which is still more knowledge based, not involved as much in projects (which country offices are mandated to do) (NP2).
>
> [we don't work with sic] so much UNDP, strangely enough, we are better collaborators with OSCE, expression of complexity – UN – UN and country offices etc, they have their own ideas (P8).

Despite certain fundamental differences, partners established a co-operative relationship, specifically around environmental issues. There are 'fuzzy boundaries' between environmental issues and other sectors such as social and economic (Conca, 1995); perhaps this is why it is a good starting point to initiate organisational co-operation, because it touches everything in some way and so is applicable to all.

These differences between organisations were refereed to as prominent by 54% of those interviewed. It may be that it is a case of imagined and enacted roles (Law, 2003). The role of regional centres may be imagined by country offices in such a way or vice versa, regardless of the roles these agencies play. This could also apply to the role of different administration units. So in fact the mandates of the different partners bear no relation to the roles other partners imagine for them, or the role they themselves play. It is therefore important that there is clear communication of roles and responsibilities early on in the co-operative process.

5.2. DEGREE OF COMMON UNDERSTANDING

Individuals within the different organisations frequently express the feeling that individuals from other organisation don't understand the structure, rules, norms and mandate of their own organisation.

> Especially UNEP, which is much less bureaucratic, and also because it's implemented through Grid Arendal which is even looser – they have a lack of understanding of our bureaucracy and we don't understand their flexibility (P6).
>
> Much easier for [UNEP sic] to mobilise funds for consultants because Grid can work ahead of donor funds – UN has to wait for donor money to be in the bank, e.g., I worked on peripheral UN projects with funds from Vienna which was a nightmare, cant do field work (E2).

There are also biases towards the other organisations which frequently emerge, commonly: that Grid Arendal is very flexible, as is UNEP; worry about how UNEP manages its budget; UNDP is rigid and bureaucratic; and both OSCE and NATO have lots of funds.

> Well I mean the fact is that the OSCE, from our perspective, plays one of the major roles in funding in the programme because a lot of the funding has come through interactions with delegates here, through direct donation via OSCE or through getting contacts with development agencies, although not the only source of funding, NATO of course has a lot of money, but not always directly involved in the funding, have own science programmes, this creates a lot of work for OSCE, we spend a lot more time than we would like on administration reporting. This is a difficult thing, if we are raising the money and dishing it out to UNEP we are responsible for how it's spent, luckily we have very generous and flexible donors, and partners don't have to respond as much. UNDP is very stringent, UNEP I think especially Grid A, are a little less, we worry sometimes about them and money. People don't think about how much administrative work it takes to get and give out money. It would definitely be good to have someone who was the point for that, who could organise and go out to potential sources (P10).

The feeling of not being understood is also often expressed in relation to colleagues in the same department but who do not work with ENVSEC. This was an especially prevalent view in UNDP, but it was observed and expressed at other partners as well. It was also evident during participant observation that there is some scepticism as to the value of the ENVSEC initiative from experts, donors and colleagues within the international organisations. This may be a reflection of general inertia and reluctance to commit to a new programme that 'hasn't proved itself', or has a relatively small budget. It is also similar to the case for human security and the UN. Despite over a decade of the 'Annan doctrine' which takes human security as a core principle, it has yet to 'gain full political acceptance' in the UN (Timothy, 2004).

5.3. ABILITY TO CHANGE THEORIES OF ACTION

A partnership of necessity sees collaboration not as just a contractual relationship, but as integral to achieving the goals of the project.

Ricigliano, 2003, p. 450

The partner organisations of the ENVSEC initiative have reached a co-operative understanding as a result of a number of influencing factors: common understanding between friends and colleagues; requirements and desires of donor organisations; and overlapping project areas.

> Yeah because we had previous contact, working on other issues, environmental issues, we at UNEP at the regional office and there at UNDP had the program on environmental governance, they had environmental programs, and also the OSCE also had a branch working on the environment and governance. But our impression was that there was demand mostly from OSCE, to enhance their environmental profile, and OSCE

invited us together to talk to them, and we asked them basically what do you need from us (NP1).

During this process of co-operation both through ENVSEC and other programmes, individuals and indeed the whole organisations begin to change their underlying theories of action, and to 'see the success of the other's work as integral to the success of its own' (Ricigliano, 2003). What is interesting are the perceptions of those involved with ENVSEC of the nature of the co-operation, and its influence. This co-operation often becomes the defining element of ENVSEC, perhaps more so than the link between environment and security. National Focal Points talk of it as a positive characteristic, donors like it and it meets the Paris Charter directives for funding development projects (see below), and the partners themselves see it as something fundamentally different about ENVSEC.

The initiative is novel, we are all still learning how to make this fantastic idea operational and we are all pioneers of the 'delivering as one' approach. This is something which is different. I used to work in networks, partnerships, but never at this institutional level (P3).

ENVSEC is the exception; this is something that delivers a million and a half dollars a year, that has robust partnerships with other agencies, both UNEP and OSCE and others as well (P7).

The co-operation between partners is seen as novel because it goes against the norm that international organisations operating in similar areas, and even between programmes within the UN family, develop a competitive relationship, and it is often difficult to overcome this. ENVSEC does experience some institutional barriers, but it succeeds in creating a functional co-operative programme.

As for negative experiences of working with UNEP – the negative arguments prevent us from working closer, ENVSEC tries to distance itself from these factors and try to base our co-operation on the basis of value added, into the programme, national level issues – country offices, UNEP should implement programmes through these UNDP country offices, UNEP sometimes wants to go and get in touch with MOE [Ministry of Environment sic] on their own, and sometimes this creates problems (P5).

One significant point made by 13 interviewees, and perhaps a reason these institutional barriers between organisations have been broken, is the importance of personal relationships between individuals within the initiative. Fifty percent of those interviewed stated that personal relationships were either very important or important. These relationships are described as close friendships, and are considered to be an underpinning element of the success of the co-operation.

There are a number of people in the organisations who work together well personally, like to work together, usually not a case of 1st 'what's in it for me?' but overall climate and working to move forward, its very good (P8)

Individual level, middle management drives it, takes a lot of good will of people to overcome institutional barriers, need to be will and personal investment to make the partnership work, which is present a great deal in the partnership (P2).

5.4. RESOURCE MANAGEMENT

It is a fact universally acknowledged that a programme in possession of a good fortune is in want of a partner. The actions and function of any organisation, regardless of how large or small, are fundamentally related to its access to resources. Resources can be human capital, physical space, but most commonly, when people refer to resources, they mean money. Both from participant observation and interviews, it is clear that a great deal of conflict within the initiative, both between different partners, and within those individual organisations, revolves around resources, predominately money, the allocation of it, the accounting process of that allocation, and access to new resources.

> When ENVSEC started I was interested in it in an empirical way; of course as a worker for an organisation I have to look at it from a resource perspective. From a personal position I do look at it from a more abstract perspective – that's how (P12).
>
> Umm basically in the energy and environment group we have two kinds of projects, we have GEF projects, and we have non GEF projects. The GEF projects reflect a certain bureaucratic logic, there is money for them if they get through GEF Council, and that money almost by definition makes it possible to have a project on the scale that allows you to have some well defined results. By contrast, most of the non GEF projects that have been done by the energy and environment group and its predecessors in Bratislava since 2001 haven't had that characteristic. They've been small projects funded only by UNDP core resources, there haven't been resources mobilised from external partners, and therefore no matter how good or successful they were, they were never scaled up and they never had much impact. ENVSEC is the exception, this is something that delivers a million and a half dollars a year, that has robust partnerships with other agencies, both UNEP and OSCE and others as well (P7).
>
> I think um, they [field missions/country offices sic] see themselves as part of a process where more resources are being made available to them to make impact on important issues, from their point of view it raises their profile on environmental activities, we provide them more opportunity to act, helps them develop new contacts, in ministry, missions benefit form broadening their reach and mandate to include environment. In Georgia for instance they see really really good inroads in to frozen conflicts, for confidence building and lead to more co-operation (P10).
>
> A key driving force of Country Office is to mobilise funds and delivery – and their performance is rated on this. The other area Country Offices are valued is giving high level advice to government – this must be very high level – like WTO or something. So in order to engage/motivate Country Offices with ENVSEC – there are 2 options –deliver large amount like 1 million dollars, or touch on issues that are very high up in the political agenda. As long as these two are missing – it's hard to motivate people – unless they really like a topic and volunteer their own time after they have done their regular job but then that is limited and stops if that person leaves their position – this is not just an ENVSEC problem but one of many regional programmes because Country Offices don't see what they get from these programmes (NP2).
>
> Access to some funding [attracted us to ENVSEC sic], not normally available – we supply substance and they the money, from our point of view, very good… both me and boss don't buy into ideological basis of ENVSEC, sort of made up, difficult to describe what it is, what is ENVSEC – especially at the beginning (P8).

Here we get the impression from interviewees that resources and money is the key driving force for people to become involved with a project or programme; however, considering the limited amount of funding available through ENVSEC; one has to ask if this perception is correct. Whatever the answer to this question, we come away with the understanding that money does factor, and that it is perhaps more of a factor for country offices and field missions than for the National Focal Points, as there is no financial reward for this position.

We also see that resource capture is a critical issue in terms of evaluating performance of actors. They feel that by securing more funding they are more important, it is a measure of the success of the programme:

> Personally I wish we could do more in terms of addressing the issues we find. We do assessments well, bring in stakeholders well, what we do a little less well, we also do well capacity building, what we could do more, is address them more, but in order to do that we need more resources, that's why fund raising is so important. If we had more funding we would be seen as being more successful, I think the countries probably wish we could help to clean up a river, or a factory. I'm not sure even if you have money, you can go after these things (P10).

5.5. FUNDRAISING

Fundraising is a key element of the resource discussion. As one would expect, fundraising is a very complicated issue for the ENVSEC initiative, not least because all the partner organisations have different methods of fundraising. This can be both a negative and positive, negative because it takes a great deal of co-ordination to track fundraising and direct it to specific projects. But this is a positive because with a variety of different fundraising mechanisms available, and a number of different networks of contacts and acquaintances being targeted, more funding options are available.

> Fundraising is an issue. Definitely we need work there. All partners have different ways of fundraising – OSCE don't do any external fundraising – REC works another way. What has been missing is a co-ordinated effort from all the Managing Board Members – need to do a better job to work together (P12).

Even so, some consider the donor network of ENVSEC to be small, and think that fundraising needs to be increased and better co-ordinated:

> - What are the major failures?
> - Underestimation of the (financial) conditions to realise successful implementation of phase 2 (D2).

> I try to spend quite a lot of time on fundraising, and they are slow processes. First you have to make the contact, and send them materials, feed back, of course in my opinion it shouldn't be this way, that you do fundraising only when you have time because it's such a crucial part of the role, the life of the initiative. But it is something that I would need a

> lot of time for. My feeling is that ok we have been pretty well supported, at the moment the economy is quite healthy, it's not a big problem, but still I think that it should be more consistent. Our contact with the donors, and this is something that I would like to do more if I had the time, but quite often I have urgent and pressing issues. There are different channels, first of all of course colleagues working for the initiative all really have some contacts, Frits knows a lot of people, and know their priorities and strategies of governments, and then we organise these meetings – like the Advisory Board meeting is the one occasion where it's possible to find out the priorities and interests of certain countries, and then sometimes they indicate quite directly that they are interested in a certain region or country or specific theme like mining, and then we organise different kinds of events through OSCE; this comes through my personal contacts with people working for the Prime Minister of Finland, there are certain countries who really support this approach to ENVSEC (P4).

Donors drive fundraising, and in this respect the initiative has a very strong position. It has perhaps adapted well to the donor requirements of co-operation between organisations laid out in the OECD Paris Declaration on Aid Effectiveness (Paris Declaration), and this is yet another example of external forces creating legitimacy for the initiative. This can be seen as a logistic consideration moulding the activities of international organisations, specifically concerning peace building and conflict resolution (Ricigliano, 2003):

> - What was the most impressive feature of the initiative when considering funding ENVSEC?
> - Its ability to create a dialogue between conflict prone parties, and their compliance with the Paris Declaration (donor co-ordination) (D1).
>
> Donors are bound by the Paris Declaration, or was it the Montreal Protocol, on donor giving, and ENVSEC meets these guidelines very well. We don't do this very well, we haven't got there. The secretariat is getting to this, but this is one person. With this loose reporting scheme, fundraising, we have failed in increasing the support of ENVSEC based on good results, and we rely solely on CIDA and thank god they have shit loads of money. We are not yet seen in that way by other countries, we aren't visible enough (P9).

Fundraising was mentioned by three as an important challenge for ENVSEC, particularly as the initiative moves from the assessment phase to the implementation phase. Four interviewees claimed fundraising was a point where ENVSEC had failed to reach its potential.

As mentioned above, resources can mean something other than money. A valuable resource for ENVSEC is the time people spend working on the initiative. This is important in terms of the National Focal Points in participating countries who do not get any reimbursement for their time and participation in ENVSEC is seen as part of their role in the various ministries they work for. Also members of partner organisations who do not have a time allocation specifically for ENVSEC, this is the majority of actors, at the time of writing there were only three members of the team who were solely attached to ENVSEC and had no other commitments. This creates a situation where people feel they are volunteering their own time to the initiative. Some actors oppose this view and see that participating in ENVSEC fulfils the roles of these actors in various ways and so they should not expect financial input. This is particularly true of views of proposals to aid NFPs. Regardless, volunteering time is seen as a factor in the functioning of ENVSEC:

> And there isn't recognition of stuff, organisations are putting in themselves. There has to be a balance between what organisations are already putting in (time, money) and the management function where money is given (P12).
>
> So in order to engage/motivate country offices with ENVSEC – 2 options – whether deliver large amount like 1 million dollars, or touch on issues that are very high up in the political agenda. As long as these two are missing – it's hard to motivate people – unless they really like a topic and volunteer their own time after they have done their regular job but then that is limited and stops if that person leaves their position – this is not just an ENVSEC problem but one of many regional programmes because Country Offices don't see what they get from these programmes (NP2).
>
> - How much time do you spend on ENVSEC work?
> - Much too much. I shouldn't spend any time becau se I'm not financed by ENVSEC, but I do spend time, 40 – 50% sometimes, all of a sudden. I try to limit it to 20% - which included some projects like biodiversity and mining, but these are actually UNEP, Balkan convention, but I don't consider it ENVSEC. Projects have a lead agency so some UNEP, so it's difficult to say what is ENVSEC and not (P1).
>
> However there are not enough people doing real work to move things along fast enough – and you lose legitimacy if you don't deliver – particularly concrete interventions. Need to promise little and deliver. Under-resourced – not enough capacity – good people on ENVSEC but they have day jobs, just like me, I have other stuff to do (E2).

With the above situation: differences between organisations; lack of understanding of roles; limited funding and lack of funding co-ordination; performance related to fundraising and allocation; and highly overlapping operational areas, it is not surprising that competition develops between organisations. Turf wars between large organisations are common (Ricigliano, 2003), and co-operating in a programme does not stop this bickering. Individuals within the partner organisations demonstrate a high degree of loyalty to their home organisation. Thirty-eight percent of interviewees stated that loyalty to organisations was very high or high.

This competition is not limited to that between separate organisations, but also occurs between different entities within the same organisation (UNDP vs. UNEP) and even within the same programme:

> I see how hard people at ENVSEC work, I see how hard the political negotiations are and so many partners makes it harder, they have in a way forgotten the country offices, they want to work directly with the stake holders or affected parties. It seems to create unhealthily competition between the Country Office and Regional Office for funds from donors – they should have far clearer division between the role of the Country Office and the Regional Offices (NP2).

6. The Role of International Organisations in Conflict Resolution

The ENVSEC initiative is practical implementation of many conflict prevention and mitigation theories. The role of international organisations in conflict mediation and resolution is well documented. One of the most interesting and important aspects of the ENVSEC initiative is not perhaps its linking of environment and security, but its conflict prevention actions, at not necessarily the normal levels of action expected by international organisations. It is an agency with low political and financial power, and yet as a third party, it plays a unique role at the societal and regional levels. Other important factors include the initiative's co-ordinated approach to international organisation operation in a strategic way.

ENVSEC acts as a third party in conflict resolution. Third parties can either be powerful and bring a great deal of resources to bear, or powerless, and have no resources but 'whose role is confined to communication and facilitation' between conflicting parties (Ramsbotham et al., 2005, p. 20). In the majority of cases ENVSEC's role is clearly the latter. In terms of amounts of resources it can contribute, ENVSEC is a small player. It is also not a very great political entity, it does have the support of the regional bosses of the international organisations, but it does not mobilise heads of state or Secretary Generals on a regular basis. However, the role of such a third party is very important, and can contribute a great deal to societal and regional conflict resolution, by acting at different levels than highly powerful monetarily and politically third parties. It is here that ENVSEC makes its most important contribution to the conflict resolution field. By acting as a medium to provide information, co-operation and training, it can shift behaviours and perceptions on a societal level. Third parties of this sort can also 'change the conflict structure and allow a different pattern of communication, enabling the third party to filter or reflect back the message, attitudes and behaviour of the conflictants' (Ramsbotham et al., 2005).

By focusing its third party mediation activities on the environment, ENVSEC promotes peace building via human security, strengthening multilateral bonds, and strengthened institutional and civil society capacities (Papa, 2006).

6.1. INTERNATIONAL ORGANISATIONS AND PEACE BUILDING

There are generally considered to be three 'generations' of international peace operations (Ramsbotham et al., 2005; Schemidl and Oakley, 2000). The period 1948–1989 was characterised by diplomatic peace keeping between states; 1989–1994, the second generation, saw military peace enforcement; and the third generation from 1994 is dominated by peace maintenance.

Peace maintenance requires that diplomatic activities, humanitarian assistance, military and civilian forces are co-ordinated and harmonised (Schemidl and Oakley, 2000). ENVSEC fits into the general peace maintenance framework of third generation international community peace operations by focusing on capacity building and providing technical assistance and co-ordinating activities between the main international organisations for security in the regions in which it operates.

Figure 2 illustrates the common roles and actions of different levels of conflict resolution actors. What is important about the ENVSEC initiative is that while it is represented by high level actors and international organisations, and the governmental level is key, its actions are characterised by the middle level approach to conflict resolution – good offices, conciliation, and problem-solving. While it must be recognised that all three tracks for conflict resolution are integral to the ultimate outcome of peace, making connections between the tracks also provides more opportunities for regional, national and societal conflict resolution to be integrated and so strengthen the outcomes.

By linking the environment to security, ENVSEC not only provides links between conflict resolution high and medium tracks, it also illustrates the links between these resolution tracks and conflict triggers at the society, regional and global level. Environmental concerns and remedies are increasingly considered from a global and regional level, because this is where their effects are felt. The emphasis of ENVSEC is regional; however the levels above and below are represented because it is a co-operative effort from international organisations, and because of the key role the state plays in all its efforts. This is reflected in the instruments used by the initiative.

International relations are based on three instruments: intervention, isolation, and influence. The ENVSEC approach focuses on the latter – working with many agencies to persuade states to reach consensus on environmental issues that influence security, and working to provide some sort of solution to these issues, usually through capacity building, institutional development and the provision of sound scientific information. The regions of operation are also not regions where the international community is currently seeking to intervene. However, intervention is a defining aspect of the international community's role in the conflicts in South Eastern Europe, and Afghanistan is on the periphery of ENVSEC's operations in Central Asia. But ENVSEC has played no role in intervention in the past; indeed it could be seen to go against its core principle of seeing the environment as a forum for co-operation. Similarly, there are no isolationist methods in the initiative, quite the opposite, even with uncooperative states; inclusion and dialogue are the preferred modes of operation.

Therefore, the tools of diplomacy available to the initiative are those of influence, the carrot, rather than the stick. When states are unwilling to co-

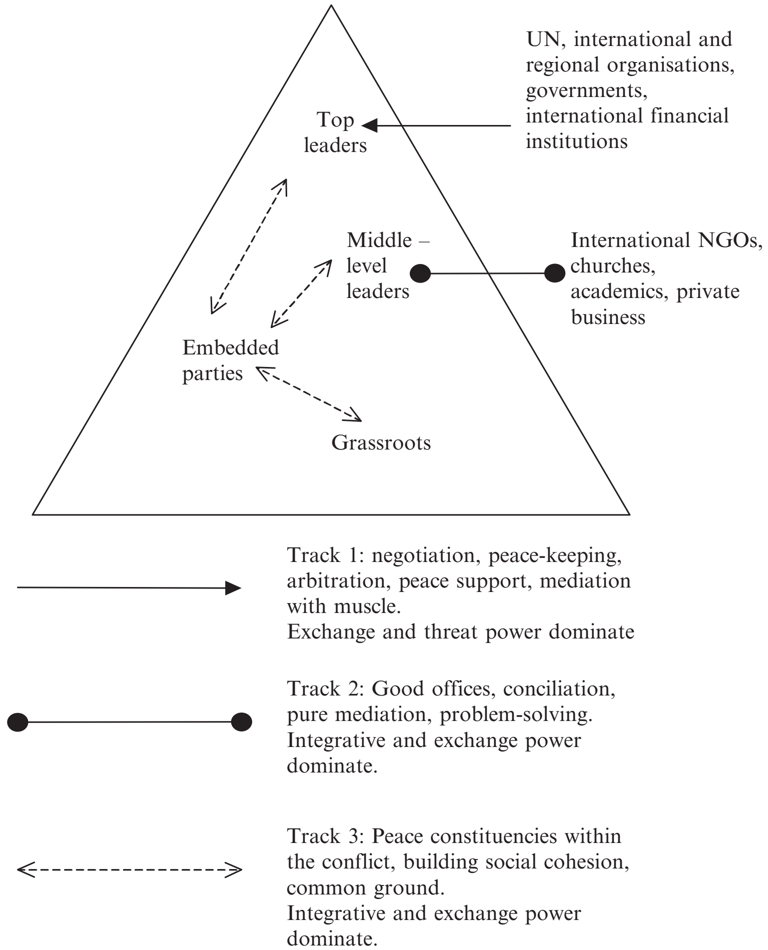

Figure 2. Multi-track conflict resolution (Adapted from Ramsbotham et al., 2005).

operate there is little the initiative can do other than trade off projects that governments desire against those they don't, and hope to induce involvement. Influence is a gradual process, institutions change slowly, their memory is often short, and agendas change quickly. Influence requires constant involvement and a patient disposition. Unfortunately, those who provide the funds often need to see results immediately.

International organisations such as the UN, OSCE and NATO are involved in a broad variety of peacekeeping practices. These range from military patrols, observation of cease fire, to political monitoring (elections and referendums), and building governance institutions such as police and judicial bodies, through humans rights monitoring and humanitarian assistance, as well as refugee monitoring and repatriation (Woodhouse and Ramsbotham, 2000). ENVSEC can been seen as one more tool in a broad toolkit tackling complex and acute issues in as many and varied ways as possible.

There is a difference between conflict management and conflict resolution. Conflict management does not address the underlying causes of conflict and sustains an often unbalanced *status quo* (Woodhouse and Ramsbotham, 2000). Both are needed in the real world, but at different points during the conflict continuum. Different stages of the conflict continuum also require different strategies for conflict prevention, peace-building, and the transformation of failed societies.

ENVSEC is operational in various stages of conflict. In the Southern Caucasus there are a number of entrenched frozen conflicts that require conflict prevention strategies, while South Eastern Europe is in the latter stages of peace building. It is vital that the approaches to the conflict situations in these different regions are mindful of the different strategies required. In South Eastern Europe a predominantly peace-building/transformation approach is needed, whereas in the Southern Caucasus a combination of pre-violence and escalation strategies is needed.

For ENVSEC to fulfil its role as a peace building initiative, it needs to work more closely with peace keeping/building agencies. Without this it is simply an environmental assessment initiative with a slightly more political edge than other international organisation environmental assessment initiatives. This political edge comes from the context it works within rather than as a consequence of its methods.

In countries where human security has 'completely broken down' the international community needs to not only prevent violence, but to also sustain peace. It needs to 'help rebuild government and civil society to balance it' to build capacity both in the institutions of government, the rule of law and in civil society. ENVSEC focuses on this very well in the environmental sector and so should be considered an important tool in a full peace building/making mission.

The international community must focus on the following when pursuing peace-building missions (Woodhouse and Ramsbotham, 2000):

- Rebuilding governments
- Rebuilding/building civil society

Conflict stage	Peace-keeping/building strategy
Pre-violence	Conflict prevention
Escalation	Crisis/humanitarian intervention
Endurance	Peacemaking and relief work
De-escalation	Peacemaking and traditional peace-keeping
Post-violence	Peace-building/transformation

TABLE 3. Tasks and skills required for peace-building.

	Tasks	Skills	ENVSEC approach
Security	Demobilisation	Non-violent defence techniques	Clean up operations such as melange and chemical waste dumps.
	Disarmament		
	De-mining	Witnessing	
	Protecting civilian populations	Accompaniment	
		Neighbourhood watch	Promoting human security, environmental justice and community level environmental awareness.
	Policing and security force reform		
		Support and networking	
	Personal security issues (e.g. racial, cultural or gender specific violence)		
	Human rights		
Governance	Institutional capacity building	Facilitating meetings	Large variety of capacity building projects
	Transparency and accountability	Developing group leaders	
			Education and training in environmental techniques and media training, regional environmental fairs,
	Electoral assistance	Group decision-making techniques	
	Civic education and training		
		Encouraging and supporting action	
	Judicial reform		
	Media development and training		Media training
			Regional convention development and implementation of international environmental conventions such as Aarhus and Espoo

(continued)

TABLE 3. (continued)

	Tasks	Skills	ENVSEC approach
	Policy development and advocacy		
Relief and development	Infrastructure development	Engineering and technical competence	Technical training and set of regional monitoring facilities
	Market reform		
	Economic and financial institutions	Business acumen	Linking farmer co-operatives with large larkers, i.e. Europe through reduced pesticide use
		Business development	
	Small business		
	Meeting basic needs	Entrepreneurial skills	
	Social services		
		Leadership and teaching	Strong trans-boundary approach to all projects
		Rebuilding relationships across boundaries	
Reconciliation	Psycho-social trauma	Interpersonal communications	
	Reintegration of refugees and displaced people		
		Groups facilitation	
	Peace education	Managing psycho-social dynamics of conflict	
	Community based initiatives		

- Supporting public space in which issues are debated
- Replacing the infrastructure of government, media, meeting places, community and leaders

The ENVSEC approach to implementing its work programme tackles a number of these points, through capacity building and training for bureaucrats, diplomats and members of civil society, training for the media, community level environmental fairs, and the collection and dissemination of objective information about the environment. In order to operate within a peace building/keeping context, a number of skills have been identified (Woodhouse and Ramsbotham, 2000); these are explored in Table 3.

We can see that ENVSEC focuses its actions on the governmental level of peace building, and does not have the skills for reconciliation.

Reconciliation requires ground level community work and local NGOs are extremely well suited for this macro level work. International organisations such as the UN, OSCE and NATO are based in capital cities and are set up for top down work. This is not necessarily a problem, as long as there are support mechanisms for ground level NGOs and community leaders to initiate the sort of skills required for reconciliation.

7. Conclusions

This paper has outlined the main links between the environment and security identified by the ENVSEC initiative. It also provided an overview of important institutional attributes which influence the manner of co-operation between the partner organisations; this has shown that the initiative adopts a multi pronged approach to co-operation depending on the context of participation, decision making, the role of the secretariat, and the structure of the agenda. Open and flexible approaches are adopted and participation is encouraged at many levels of the initiative but when agreements between states are required, the principle of sovereignty is fully implemented and these processes become exclusive. This multi pronged approach allows for a degree of legitimacy that would be unachievable if the whole process was exclusive, however, it also allows for the delicate negotiations required when dealing with conflict situations. The role of the secretariat as entrepreneurial also allows for the creation of ad hoc approaches to complex situations made even more complex by the co-operative nature of the initiative.

Characteristics that emerged as important in regards international organisation co-operation concerning environment and security included the timely and clear explanation of mandate and duties of each partner organisation to other partners, the recognition of areas of expertise and the choice of methods used to reflect that expertise. This approach will help to overcome frequently cited feelings of a lack of understanding from partner organisations and from others within the same organisation but working on different projects.

Organisations must recognise that there must be an ability to change theories of action and to overcome institutional barriers in order to create successful co-operation. This must come from all levels of management. The main elements present in the creation and successful functioning of ENVSEC identified by this research were:

- Donor call for international organisation co-operation
- High level demand for inclusion of security in all sectors

- High degree of operational overlap between regional and country offices of international organisations
- Trust and friendship developed between middle and low management

Resource management and fundraising are the most significant issues when considering co-operation, and efforts need to be made to accept the complex modes of operation needed for resource mobilisation and fundraising in multi partner co-operation – it is unclear at this moment whether more detailed agreements, or less detailed and more flexible agreements would make this process less problematic.

The final section of this paper looked at the role international organisations play in conflict resolution and peace building and emphasised the need for flexible approaches that are context specific. Organisations need to recognise the level at which their actions are most effective while at the same time maximising their influence and support of grass roots and local level activities especially when considering reconciliation post-conflict. This paper also suggests that the environment is an excellent conduit to create co-operation between international organisations, regional, national and local organisations from various sectors and targeting them on conflict resolution and peace building. The environment provides theses opportunities because of the nature of environmental problems and the institutions required to tackle these problems.

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COUNTERING THREATS TO ENVIRONMENTAL SECURITY: THE ROLE OF NATO

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Abstract: The North Atlantic Treaty governing NATO contains in Article 2 an explicit recognition of NATO's role in developing peaceful international relations and promoting stability and wellbeing. This role has been implemented since 1958 through the civil (non-military) NATO Science Programme. The Science Programme was merged into a new Science for Peace and Security (SPS) Programme in 2006. The rationale of the SPS Programme is based on the recognition that cooperative activities in science can serve to promote peaceful dialogue, technology exchange and cultural understanding whilst at the same time delivering results that contribute to peace through countering diverse threats to security in a broad sense. One such threat addressed by the SPS Programme is that of adverse environmental influences occurring in circumstances where they can be a cause of or serve to amplify tension and conflict. The paper begins by setting such environmental influences in a broadly-defined security context. The evolution of the SPS Programme is explained and its objectives, characteristics and organisation are described. The range of environmental security topics included in the Programme is illustrated by some examples of constituent activities. These come from widely different areas of science but they all have in common their potential or actual impact on the environment and hence on the security and wellbeing of people, countries and regions.

Keywords: Environmental security, peace and security, scientific collaboration, technology exchange

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1. Introduction

Security can be defined in dictionary terms as individual or collective freedom from fear. This freedom at a country level is usually secured through protection against threats to territorial integrity, political sovereignty and national interests. However, this definition of security has broadened over time to embrace protection against other threats. For example, the seminal Brundtland Report on sustainable development (WCED, 1987) stated:

> The whole notion of security as traditionally understood – in terms of political and military threats to national sovereignty – must be expanded to include the growing impact of environmental stress – locally, nationally, regionally and globally.

Even though the causes of conflict and insecurity are often complex, evidence suggests that environmental degradation and resource depletion are a source of tension in many regions of the world. Land degradation, climate change, water quality and quantity, and the management and distribution of natural resources (e.g. oil, forests, minerals) are factors that can contribute directly to conflict or have an indirect link to them by exacerbating other causes such as poverty, migration, infectious diseases, poor governance and declining economic productivity. In sum, environmental problems can threaten human livelihoods and contribute to social and economic inequalities and hence to socio-political instabilities. Political recognition of these links is exemplified by a speech by Foreign Secretary of the United Kingdom Margaret Beckett on 24 October 2006 (see http://www.fco.gov.uk) in which she said:

> The foreign policy community has long understood that the stability of nations is to no small degree predicated on the security of individuals. When people are exposed to the stresses caused by overpopulation, resource scarcity, environmental degradation, as they feel the security upon which they and their families depend progressively slipping away, so we see the slide down the spectrum from stability to instability.

The concern thus expressed is being increasingly addressed by the international community taking an active role in the initiation of environmental projects across a broad front. NATO contributes to these activities through its Science for Peace and Security (SPS) programme in which environmental security topics feature as a priority. Every year, the SPS programme supports numerous environmental security projects related to issues such as water management, seismic events, different forms of pollution, disposal of radiological waste and other potential hazards. This paper describes the SPS programme and gives information on its environmental security agenda as background to NATO's support for this Advanced Research Workshop on Energy and Environmental Challenges to Security.

2. The NATO SPS Programme

NATO has for long been known essentially as a powerful military and political organization. The military and political aspects of NATO are identified as the first and second dimension of the Alliance. It is not generally known that NATO has a third dimension, based on Article 2 of the North Atlantic Treaty, which explicitly highlights that NATO has a role to develop peaceful and friendly international relations and to promote conditions of stability and well-being. This Article 2 of the Treaty is, in fact, the basis for the support of the Advanced Research Workshop whose proceedings make up this book. NATO's interest in civil science is pursued as part of its Public Diplomacy agenda. Implementing the third dimension resulted, almost 50 years ago, in the creation of NATO's Science Programme, a programme of cooperation often referred to under the slogan "Bringing scientists together for Progress and Peace".

Just as NATO has changed over the past decades, so has its Science Programme. It has changed in two ways:

1. Initially the third dimension focused on strengthening western science through Trans-Atlantic cooperation among the NATO member states. In the early 1990s, an 'Outreach' initiative was adopted especially targeting NATO Partner countries. Nowadays, the Programme encompasses NATO member states, the Russian Federation and all other Partner countries, and countries cooperating with NATO through its Mediterranean Dialogue (Algeria, Egypt, Israel, Jordan, Mauritania, Morocco, Tunisia). Among these countries, Austria, Finland, Ireland, Sweden and Switzerland participate in the Science Programme activities at their own expense. For the complete list of the 49 countries participating in this cooperative network, see: www.nato.int/science.

2. Primarily the objective was to promote the development of science and technology in NATO countries as a balance to the developing technologies of the Warsaw Pact countries. In parallel with the expansion of membership in recent times, the Programme has now been transformed into a collaborative programme with a focus on security aspects in a broad sense. Collaborative activities are funded through a variety of mechanisms, though there are varying conditions on eligibility for funding between the different countries.

The transformation of the Science Programme was achieved in 2004 under the new title Security through Science (StS) Programme. This title proved to have a short life. NATO has also supported for many years an Environment and Society Programme overseen by the Committee on the Challenges of

Modern Society (CCMS). It was decided that the StS programme and that of the CCMS should be merged and the merged programme came into being in 2006 with the current title of SPS programme.

3. Construction of the SPS Programme

The primary purpose of the SPS programme is to establish collaboration on civil science in order to:

- Mobilize and enhance R&D capabilities
- Contribute to solving problems affecting large societies
- Promote NATO's values in society at large and in targeted communities, e.g. the young generation of 'Leaders of Tomorrow' and
- Contribute to peace and security by promoting regional cooperation

Several collaborative mechanisms are used in constructing the programme:

- Advanced Research Workshops (ARWs) – to organise expert exchanges at the frontiers of a subject for identifying future directions
- Advanced Study Institutes (ASIs) – high level tutorial courses organised to convey the latest developments in a subject to an advanced audience
- Advanced Training Courses (ATCs) – to enable specialists in NATO countries to share their expertise with trainees from Partner and Mediterranean Dialogue countries
- Collaborative Linkage Grants (CLGs) – to pool ideas and resources on research projects and create specialist networks
- Science for Peace (SfP) Projects – to fund multi-year applied R&D projects
- Networking Infrastructure Grants (NIGs) – to improve the level and quality of telecommunications facilities of research institutions

The policies governing the programme are set by the SPS Committee with national representation. The programme is constructed primarily through a 'bottom-up' application-driven process though increasingly this is supplemented by identification of strategically-oriented activities in a 'top-down' process leading to specific calls for applications. In both processes, the quality of the scientific content of applications is evaluated by four panels of invited independent assessors. The panels are currently organised under the following security-related heads:

- Chemical/Biological/Physics (CPB) Panel
- Information and Communications Security (ICS) Panel

- Environmental Security (ES) Panel
- Human and Societal Dynamics (HSD) Panel

The selection of the applications to be funded is decided competitively. In addition to the assessment of scientific merit, applications have to comply with a defined system of priorities and in total must be contained within an overall funding envelope. In addition, there is a funding maximum for applications under each collaborative mechanism.

4. Prioritisation

The scope of the SPS programme is potentially so wide-ranging that a system of security-related priorities is essential for effective allocation of limited resources. Priority topics for funding are provided in two complementary lists. The first list has been established by NATO and groups the topics in two categories with a security focus. The first category of obvious relevance is entitled 'Defence against Terrorism' and measures towards that end are listed as:

- Rapid detection of Chemical/Biological/Radiological/Nuclear (CBRN) agents and weapons, and rapid diagnosis of their effects on people
- Novel and rapid methods of detection
- Physical protection against CBRN agents
- Decontamination of CBRN agents
- Destruction of CBRN agents and weapons
- Medical countermeasures
- Explosive detection
- Eco-terrorism countermeasures
- Cyber terrorism countermeasures

The second category reflects the fact that security is much more than just protection from terrorism. Security is a global concept, including of course a terrorist free environment, but also – and maybe most importantly – focusing on conditions of living, allowing development and well-being of all citizens. The topics grouped under this heading of 'Countering other Threats to Security' are currently:

- Environmental security (e.g. desertification, land erosion, pollution, etc.)
- Water resources management
- Management of non-renewable resources

- Modelling sustainable consumption (e.g. food, energy, materials, fiscal measures and environmental costing)
- Disaster forecast and prevention
- Food security
- Information security
- Human and societal dynamics (e.g. new challenges for global security, economic impact of terrorist actions, risk studies, topics in science policy)

It will be seen that the generic descriptor ‘Environmental Security’ as used in this paper captures a number of the topics in the above two categories.

The second list of priority topics comprises a selection prepared annually by NATO Partner countries according to their own individual circumstances. Applications for grants from a Partner country have preferential treatment if the topic of the application is also a priority for that country. The current top priorities across the Partner countries are environmental security, computer networking and counter terrorism. Information on prioritisation is provided to applicants through the SPS website: www.nato.int/science.

The distribution of projects that would be achieved by the application of these controls would obviously be affected by the inherent randomness between topics in the submitted applications, possibly resulting in clusters and gaps. The ‘top-down’ strategic orientation referred to earlier is a forward-looking prioritisation exercise intended as a feedback mechanism to address any such distribution effects and is implemented through specials calls for applications.

5. A Selection of Environmental Security Projects

In order to put ‘flesh on the bones’ of the policy and procedural characteristics described so far, a selection of activities on environmental security that have been or are being funded by NATO will be described below.

An Advanced Study Institute on ‘Chemicals as Intentional and Accidental Global Environmental Threats’ was held over a period of 11 days in Bulgaria in 2005. The aim was to perform a critical assessment of the existing knowledge of chemical threats to environmental security with special reference to the prevention of chemical releases, rapid detection, risk assessment and effective management of emergency situations and long term consequences of chemical releases. The technologies evaluated concerned prevention and management of both intentional and accidental releases of chemicals to the environment. The participation of lecturers from different scientific fields and young scientists allowed for a multi-media focus covering threats to food, air, water and soil. The exchange of experience of the lecturers and the young scientists' ideas in this field contributed to the finding of answers to critical questions and identification of future research needs and new approaches in management and structuring of preventive systems and methodologies.

An Advanced Research Workshop on 'Transboundary Water Resources: A Foundation for Regional Stability in Central Asia' was held over 3 days in Kazakhstan in 2006. A precursor to the workshop was a pilot study also funded by NATO on 'Environmental Decision Making for Sustainable Development in Central Asia' and completed in 2005. The study had concluded that an important problem of Central Asia was that of shared water resources, particularly in relation to the Aral Sea Basin. Mismanagement of water resources has plagued the Aral Sea Basin since the early 1960s, made worse when the Aral Sea became a transboundary water body following the collapse of the Soviet Union. The development of sustainable and equitable water management practices became the shared responsibility of five sovereign nations each with conflicting needs, goals and priorities. The Workshop was organized by scientists from the US and Uzbekistan and brought together environmental specialists from 12 countries. The programme of the Workshop included coverage of specific case studies on integrated water resource management impacting the individual republics and discussions on the legal, technical and institutional aspects of transboundary water management as well as on potential tools and approaches to deal with the issue.

A related activity on Aral Sea Basin problems was an earlier multi-year Science for Peace project on 'Use of Land and Water Resources in Karakalpakstan, Uzbekistan' to study the ecosystem of the Basin. The mismanagement of irrigation substantially diminished inflow from two tributary rivers into the Aral Sea, causing severe ecological and economic problems. Water logging, secondary salinisation, dust and salt blown from the dried sea bottom have ruined formerly rich agricultural land. The population suffers from acute medical problems associated with difficult living conditions and the degraded environment. The SfP project enabled a Geographical Information System Centre to be put into operation at the Karakalpakstan State University. With the support of Russia, the Centre developed forecast models to detect changes in the ecosystem and early crop-yield estimation models. Scientists were trained to ensure the improvement of water management and agricultural planning. The results of the project were transferred to the Interstate Coordination Water Management Commission as well as to relevant government branches and non-governmental organizations.

The availability of energy supplies, including supplies from a variety of renewable sources, is an increasingly important and recurrent topic in the environmental security agenda and the present ARW is an example of NATO efforts to stimulate wide-ranging debates on the multidisciplinary issues involved in seeking solutions. An earlier ARW, jointly organized by the UK and the Russian Federation, on ‘Emerging Threats to Energy Security and Stability’ took place in the UK in 2004. The workshop was designed to promote a public-private sector exchange on how best to address issues arising in energy security at a time of growing uncertainty. In particular, it sought to assess emerging threats to energy security and stability and discuss new security strategies to protect global energy supplies from regional instability and terrorism. The threats to critical energy system infrastructure considered included those to ships, ports and pipelines and the Workshop examined ways to strengthen international capabilities to deter and detect terrorist threats to energy supplies and to develop and coordinate bilateral and multilateral energy security and stability strategies.

A few years ago, the Stability Pact for South Eastern Europe, through its Disaster Preparedness and Prevention Initiative, initiated a project dealing with the ‘Harmonization of Seismic Risk Hazard Maps’ in countries influenced by the well-known Vrancea earthquakes (see http://www.stabilitypact.org). With NATO’s support a project involving Moldova, Bulgaria, Romania and Turkey was launched in 2004. Responding to the interest expressed by all other countries of South Eastern Europe to explore, define and negotiate the most suitable modalities to replicate this project to the rest of the SEE region, a further SfP project was set up in 2007 by NATO. This project, entitled ‘Harmonisation of Seismic Hazard Maps for the Western Balkan Countries’ will benefit NATO’s six Partner countries in the region: Albania, Bosnia and Herzegovina, Croatia, the Former Yugoslav Republic of Macedonia, Montenegro and Serbia. The project will provide a proper base for adapting technical norms to the standards defined by the European Union and will contribute to enhanced cooperation between the six countries in disaster preparedness and prevention. In addition to the funding from NATO, the project is also supported in kind by Slovenia, with seismologists from the European Commission’s Joint Research Centre in Italy and from Turkish and Greek institutes sharing expertise with their colleagues from the Balkans. It is hoped that this project will not only give a new impulse to tackling problems of seismic safety in the Western Balkans but also be a catalyst for increased co-operation between all countries in this region.

6. Concluding Remarks

The most striking element in the new concept of environmental security is its significance for global security (CCMS, 1999). Whereas, until fairly recently, environmental security was a quasi-unknown concept, it is now a high priority on the agenda of many international organizations besides NATO. Cooperation and communication are necessary prerequisites for effective international efforts to address the many problems associated with the concept. In this context, mention may be made of the Environment and Security Initiative (ENVSEC) – see http://www.envsec.org/about.php. This is an association of six international organizations – UNEP, UNDP, OSCE, NATO, UNECE and REC – for coordinating their efforts in dealing with environmental security issues. NATO's activities in civil cooperation through the SPS programme are often conducted in cooperation with these and other organizations. The funding provided by NATO is intended to prime the pump and serves to show the way to achieve lasting results but follow up efforts and longer-term financial support are generally needed. This is one of the challenges of today.

The SPS programme of NATO is essentially a tool for connecting nations through their scientific communities in pursuit of a more peaceful and stable world. Every year, the activities of the SPS programme bring together many scientists from NATO, Partner and Mediterranean Dialogue countries to initiate cooperation and establish enduring links as well as to achieve positive and practicable improvements in the countries' own capabilities to tackle the problems that affect the wellbeing of their people. It is apposite to close with a quotation from Freeman Dyson (Dyson, 1997):

> The most useful contribution that scientists can make to the abolition of war has nothing to do with technology. The international community of scientists may help to abolish war by setting an example to the world of practical cooperation across barriers of nationality, language and culture.

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TRANSATLANTIC ENERGY SECURITY

DEPENDENCE ON MIDDLE EAST ENERGY AND ITS IMPACT ON GLOBAL SECURITY

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Abstract: The concentration of so much of the world's hydrocarbons in the Middle East is a contributing factor to a slew of economic and national security problems affecting the region and the world at large. The region is riddled with deepening ethnic and political tensions, terrorism, corruption and authoritarianism. In addition, there are problems that have no solution in sight and that will no doubt directly affect the supply of energy from the Middle East, among them protectionism, lack of investment, unresolved border disputes and the growing uncertainty about the political stability of key energy producers like Saudi Arabia, Iran, and Iraq. These problems are likely to be intensified as demand for oil grows. The region's problems will no doubt impact not only the world's economy and security but also consuming nations' attitudes and policies toward the region's producers as well as toward each other.

The only way consumers can check the region's influence is by putting their collective weight together to act in a unified manner to counterbalance OPEC through a shift to alternatives while bringing the cartel to adopt policies conducive to energy security that are necessary to bring down oil prices.

"We do have to do something about the energy problem. I can tell you that nothing has really taken me aback more, as Secretary of State, than the way that the politics of energy is […] 'warping' diplomacy around the world. It has given extraordinary power to some states that are using that power in not very good ways for the international system, states that would otherwise have very little power." Secretary of State Condoleezza Rice, testimony before the U.S. Senate Foreign Relations Committee, April 5, 2006.

Throughout the 19th century nearly half of the world's crude oil supply came from the gushing oilfields surrounding the Azeri city of Baku. At that time, petroleum supplied only 4% of the world's energy, giving the Caspian region little strategic advantage in the international stage. But as the world economy embarked on a steep growth trajectory, dependence on petroleum

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grew significantly. Today, oil supplies about 40% of the world's energy and 95% of its transportation energy. As a result, those who own the lion's share of the reserves of this precious energy source are in the driver's seat of the world economy, and their influence is steadily growing. Since the 1930s the Middle East has emerged as the world's most important source of energy and the key to the stability of the global economy. This tumultuous region produces today 37% of the world's oil and 18% of its gas. When it comes to reserves, the Persian Gulf is king. It is home to 65% of proven global oil reserves and 45% of natural gas reserves. The Middle East also controls a significant portion of the hydrocarbons that are yet to be discovered. According to the U.S. Geological Survey over 50% of the undiscovered reserves of oil and 30% of gas are concentrated in the region primarily in Saudi Arabia, Iran, Iraq, Kuwait, UAE and Libya.

The concentration of so much of the world's hydrocarbons in this geographical location means that as long as the modern economy depends on the supply of oil and natural gas, the Middle East will play a key role in global politics and economics. As it is, most of the world's countries are heavily dependent on Persian Gulf oil. In 2006, the Middle East supplied 22% of U.S. imports, 36% of OECD Europe's, 40% of China's, 60% of India's, and 80% of Japan's and South Korea's. Even oil-rich Canada is dependent on the Middle East. Forty-five percent of Canada's oil imports originate in the region (EIA). Barring a major technological transformation, global dependency on the Middle East is only going to grow. According to the International Energy Agency, from now until 2030 world oil consumption will rise by about 60%. Transportation will be the fastest growing oil-consuming sector. By 2030, the number of cars will increase to well over 1.25 billion from approximately 700 million today. Consequently, global consumption of gasoline could double. The two countries with the highest rate of growth in oil use are China and India, whose combined populations account for a third of humanity. In the next 2 decades, China's oil consumption is expected to grow at a rate of 7.5% per year and India's 5.5% (compared to a 1–3% growth for the industrialized countries). As a result, by 2030 Asia will import 80% of its total oil needs and 80% of this total will come from the Persian Gulf. The reason why Persian Gulf countries' share of the world's energy pie is likely to increase has to do not only with geology but also with resource management. While non-Middle East countries pump at full speed, Middle East producers, many of them members of the Organization of Petroleum Exporting Countries (OPEC), stick to a quota and produce well under their capacity. This means that non-OPEC oil is running out almost twice as fast as OPEC's. Exxon Mobil Corporation has estimated that non-OPEC production – this includes Russia and West Africa – will peak within a decade, making recoverable oil left outside the

Middle East scarcer and scarcer (Oil and Gas Journal, 2004). On the other hand, the reserve-to-production ratio among Persian Gulf producers ranges between 80 and 100 years, allowing those countries to stay in the race decades after their competitors have depleted their reserves. This is likely to lead to global dependence on the region of an unprecedented scale with considerable implications for global security and the global economy; as the Chief Economist of the International Energy Agency put it: "We are ending up with 95% of the world relying for its economic well being on decisions made by five or six countries in the Middle East" (Wall Street Journal, 2005).

Conventional wisdom, concerned only with the smooth functioning of the market, says that ownership of oil is meaningless, that it does not matter much if most of the world's oil is owned by one regime or the other. But in the case of the Middle East, resource ownership does matter. The region is riddled with deepening ethnic and political tensions, terrorism, corruption and authoritarianism. In addition, there are problems that have no solution in sight and that will no doubt directly affect the supply of energy from the Middle East, among them a growing rift between Sunnis and Shiites, tensions between the West and an increasingly radicalized Muslim world, increasing terrorist activity against oil facilities, protectionism, lack of investment, unresolved border disputes and the growing uncertainty about the political stability of key energy producers like Saudi Arabia, Iran, and Iraq. The energy security and national security problems resulting from reliance on a single energy resource that is primarily located in such a volatile area are likely to be intensified as demand for oil grows. The region's problems will no doubt impact not only the world's economy and security but also consuming nations' attitudes and policies toward the region's producers as well as toward each other.

1. Impact on the War on Radical Islam

Despite promises by Middle Eastern governments to stop terrorist financing, 6 years after September 11, wealth generated by the region's oil rich countries continues to flow to terrorist organizations and organizations promoting radical Islam. It is impossible to precisely know the extent of the phenomenon, but there is no doubt that a portion of the petrodollars sent to the Middle East finds its way – through official and unofficial government handouts, charities and well-connected businesses – to the jihadist movement. In this, the most problematic country is the region's leading oil producer, Saudi Arabia. Prior to September 11, Saudi nationals were the largest contributors to al Qaeda and its affiliates. To forestall open condemnation by its fundamentalist Wahhabi religious establishment, the Saudi regime has for many years placated the clergy by bankrolling its growth while striking an unspoken deal with the radicals: go wreak havoc anywhere you want as long as you keep us out of your harm's way. This deal entailed a constant infusion of money into thousands of mosques and madrassahs that preached hatred and intolerance throughout the world. With a little over 1% of the world's Muslim population the Saudi Wahhabis support 90% of the expenses of the entire faith, overshadowing other, more moderate traditions within Islam (Wright, 2006). In July 2005, U.S. Undersecretary of the Treasury in charge of fighting terrorist financing Stuart Levey noted: "Wealthy Saudi financiers and charities have funded terrorist organizations and causes that support terrorism and the ideology that fuels the terrorists' agenda. Even today, we believe that Saudi donors may still be a significant source of terrorist financing, including for the insurgency in Iraq" (Levey, 2005). More recently, Levey said in an interview: "If I could snap my fingers and cut off the funding from one country, it would be Saudi Arabia" (ABC News, 2007). Another Middle Eastern country that thrives on the current oil bonanza is Iran. The Islamic Republic's theocratic regime is known to support and provide training to terrorist groups like the Shiite Hizballah as well as to Sunni radical groups such as the Palestinian Hamas and the Taliban in Afghanistan. It also supplies weapons to Shiite insurgents who fight the U.S. and its allies in Iraq.

Growing dependence on the Middle East means further enrichment of the corrupt and dictatorial regimes in the Persian Gulf and continued access of terrorist groups to a viable financial network which allows them to remain a lethal threat to the West. It would also necessitate an increased Western military presence in the region to ensure access to oil. But such a presence would only strengthen the xenophobic and anti-Western sentiment among the jihadists and increase their motivation to fight the infidels. Furthermore, continuous infusion of money to radical Islamic educational institutions creates a new generation of radicalized youth, making reconciliation between the West and the Muslim world more difficult to achieve. This vicious cycle can only be broken through massive political reforms that the oil regimes currently seem to resist.

2. Impact on Human Rights and Democracy Promotion

Studies show that countries rich in easily extracted and highly lucrative natural resources that do not have well developed democratic traditions do not sufficiently invest in education, productivity, or economic diversification. In addition, such resource-rich governments do not feel obligated to be accountable or transparent to their people and they deny them representation. They also have no imperative to educate women and grant them equal rights. While their oil wealth allows them to be the strategic pivot of world politics and economy, these "trust fund states'" record on human rights, political stability and compliance with international law is abysmal. Although Persian Gulf countries have made an effort not to repeat the reckless spending policies that accompanied previous spikes in oil prices, diversifying their investment portfolios and strengthening their non-oil sector, they still continue to use oil revenues as a means to maintain their power, allowing freedom and democracy to advance at an extremely slow pace if at all. In some places the petrodollar influx only causes a reversal in the progress toward freedom. As New York Times columnist Thomas Friedman noted in what he calls "the first law of petropolitics," the price of oil and the pace of freedom always move in opposite directions in authoritarian countries highly dependent on oil and gas for their GDP (Friedman, 2006). If democratization makes any significant progress in the Middle East it only happens in countries that do not rely on energy exports like Jordan, Bahrain, or Morocco.

3. Impact on Regional Stability

Despite the high visibility of the Arab-Israeli conflict, historically, wars among Muslim countries in the Middle East have caused far bigger losses in terms of both blood and treasure. Such conflicts have been a destabilizing factor for the global energy market. Both the Iran–Iraq War and the 1990 Iraqi invasion of Kuwait caused energy crises that were followed by recessions. In such a combustible environment feeble and insecure regimes flush with petrodollars feel the need to arm themselves to the teeth, fueling a regional arms race which only contributes to the general sense of insecurity. This problem is now being exacerbated by the deepening rift between Sunnis and Shiites as it expresses itself in Iraq. While Sunnis constitute the lion's share of the Muslim world as a whole, in the Persian Gulf Shiites comprise a 70% majority. This means that the divide between Sunnis and Shiites will inescapably affect the oil market. Increasing sectarian violence and inability to reach an acceptable wealth-sharing compromise are taking a heavy toll on the Iraqi oil industry with profound implications for the global oil market. Four years after the U.S.-led invasion, Iraq has not been able to match its pre-war crude production level of 2.5 million barrels per day. Due to non-stop sabotage taking place in the north, Iraq was barely able to produce 2.1 million barrels per day in 2006. Perhaps the biggest casualty of a spillover of Muslim sectarianism would be Saudi Arabia. The eastern province of Saudi Arabia is home to most of the Kingdom's giant oil fields and export terminals. It is also the home of the bitter Saudi Shiite minority. Shiites make up roughly 15% of Saudi Arabia's population of 25 million. They are treated as second-class citizens and they harbor strong antagonism against the Kingdom's Wahhabi establishment which considers them heretics. Should an Iranian inspired Shiite revolt break out, the damage to the Saudi oil industry and the world economy at large could be incalculable.

A second destabilizing factor with certain impact on the oil market is the looming crisis with Iran. While the U.S. and the European Union are trying to forge a diplomatic strategy to halt Iran's nuclear program, Iran seems determined to pursue its nuclear ambitions. In an effort to foil Western attempts to isolate it diplomatically, Iran strengthened its relations with Russia and other energy producing Central Asian countries and it has also utilized its energy resources to purchase diplomatic protection from China and India. Tehran's diplomatic dance with China, the number one oil and gas importer from Iran, is the one Iran counts on most. The two countries are bound by energy deals reaching a total value of roughly $100 billion, guaranteeing that China will use its veto power to block any American effort to impose strong economic sanctions against Iran in the UN Security Council. Iran's continuous defiance could produce two undesirable outcomes. In the near term it could escalate to a military confrontation between Iran and the U.S., an eventuality that will no doubt disrupt the free flow of oil through the Strait of Hormuz and send oil prices to unprecedented levels. If Iran does succeed in becoming a nuclear power, the long run consequences could be far more severe. A nuclear Iran will not only be a threat to the region – Iran's President Mahmoud Ahmadinejad is a strong advocate of the destruction of Israel – but it also guarantees that other Middle Eastern countries will follow suit. Many regional actors including the Gulf Cooperation Council (GCC), Yemen, Egypt, Jordan and Morocco have already declared their intention to develop nuclear capabilities albeit "for peaceful purposes." But such peaceful projects are often harbingers of nuclear military programs. Some predict that the nuclearization of the Middle East could result in a more restrained behavior by its countries as was the case of the balance of power between the U.S. and the Soviet Union during the Cold War years. But considering the history of miscalculations and erratic behavior by some of the Middle East's regimes, it may be a leap of faith to expect the same composure and restraint that was exhibited by the great powers. Hence, a nuclear Iran enabled by the new energy reality and in particular the Chinese and Indian dependence on its energy should be perceived as one of the most destabilizing developments of our time.

4. Impact on Global Security

As nations become increasingly dependent on oil, it becomes strategically imperative for them to secure their access to the Middle East. This means building strong alliances with the region's suppliers, providing them with diplomatic support and military aid and often turning a blind eye to their human rights transgressions. Since the famous 1945 meeting between U.S. President Franklin D. Roosevelt and the Saudi King Abdul Aziz ibn Saud aboard the USS *Quincy* in Egypt's Great Bitter Lake, it was the U.S. that served as the guarantor of security and stability in the Persian Gulf. In fact, the use of military power to ensure the free flow of oil from the Persian Gulf has been a tenet of U.S. national security strategy. According to the Carter Doctrine, put forth by President Jimmy Carter in 1980, any effort by a hostile power to block the flow of oil from the Persian Gulf to the U.S. will be viewed as an attack on America's vital interests and will be repelled by any means necessary including military force. Since then, the U.S. has exercised the Carter doctrine several times. When, during the Iran–Iraq War, Iranian forces attacked Kuwaiti tankers, President Ronald Reagan authorized "reflagging" and provided them with U.S. Navy protection. Then, following Iraq's invasion of Kuwait in 1990 President H.W. Bush authorized military action aimed to defend Saudi Arabia's oil fields and restore Kuwait's sovereignty. In the decade between the Gulf War and Operation Iraqi Freedom, the U.S. strengthened its military presence in the region, building bases in Qatar, Bahrain, and Kuwait. At a cost of $50–60 billion per year it patrolled the waters of the Gulf, imposed a no-fly zone in Iraq and provided training and equipment to the region's militaries.

Throughout the Cold War years, the *Pax Americana* in the Middle East was rarely challenged. The Soviets had strategic interests in the region but being oil rich their economy was hardly dependent on Middle Eastern oil. All this is going to change with the economic ascendance of oil-poor China and India. In the coming decades, the Middle East will turn increasingly to Asia to market its oil and gas. By far the most important growth market for countries like Iran and Saudi Arabia is China, which is today the world's second largest oil consumer and which by 2030 is expected to import as much oil as the U.S. does today. To fuel its growing economy, China is following in America's footsteps, subjugating its foreign policy to its energy needs. China is attempting to gain a foothold in the Middle East and build up long-term strategic links with the region's producers. Though some optimists think that China's pursuit of energy could present an opportunity to enhance cooperation, integration and interdependence with the U.S., there are ample signs that China and the U.S. could already be on a collision course over oil. For China, the biggest prize in the Middle East is Saudi Arabia, home of a quarter of the world's reserves. Since September 11, tensions in U.S. –Saudi relations have provided the Chinese with an opportunity to win the hearts of the House of Saud. As mentioned before, to Washington's dismay, China has also set its sights on Iran, announcing that it will not support sanctions against Iran in the UN Security Council. There is no doubt that, as China's oil demand grows, so will its involvement in Middle Eastern politics. China is likely to provide the region's energy exporters not only with diplomatic support but also with weapons, including assistance in the development of WMD. India is no less of a challenge. Unlike China whose geography allows oil imports from neighboring Russia, India's only nearby source of oil and gas is the Middle East. In recent years, India has grown increasingly interested in signing energy deals with Iran, Saudi Arabia and the UAE. Just like China's, India's engagement with Iran provides the Islamic Republic an economic lifeline at a time when the West is trying to isolate it. Such growing bonds have already compromised India's relations with the U.S. All this means that in the long run, as China's and India's dependence on the Middle East grows, they are likely to increasingly challenge U.S. policy in the Middle East, turning the region from a unipolar region in which the U.S. enjoys a near uncontested hegemony into a multipolar system in which more and more global powers vie for influence.

5. Impact on the Global Economy

In 2005–2007, despite political instability, hurricanes and unquenchable demand from developing Asia, OPEC refused to increase production, maintaining a band ranging between \$60 and \$90 per barrel in comparison to the earlier part of the decade when oil prices fluctuated between \$20 and \$30. This caused a transfer of wealth of historical proportions from the world's consumers to the coffers of Middle Eastern producers. As President Bush said in April 2004, U.S. dependence on overseas oil is a "foreign tax on the American people" (CNN, 2005). Indeed, oil imports constitute a third of the U.S. trade deficit and are a major contributor to the loss of jobs and investment opportunities. The transfer of wealth resulting from the cartel's greed is reshaping the world economy. Flushed with petrodollars, oil producers are using their money to buy critical nodes of the West's economies including equity firms, banks, stock exchanges, media conglomerates and retail chains. Altogether overseas acquisitions from the Arab world amounted to \$68 billion in 2007 and additional tens of billions of dollars are still awaiting a place to park. Such holdings enable Arab governments unprecedented influence on Western economies and politics.

For energy importers the rise in oil prices means slower growth rates, inflation, loss of jobs and burgeoning trade deficits. The biggest casualties are the developing nations, some of whom still carry debts which go all the way back to the oil crises of the 1970s. The recent change in the trade patterns of the Arab oil producers could potentially bring about the decline of the

U.S. dollar as the main reserve currency, a process that may already be on its way. Arab countries have grown more dependent on imported goods from Europe and Asia rather than the U.S. Since it is now Euros and Yen that need to pay for the Arabs' imports, Arab governments think more and more in terms of non-dollar currencies. At a time when the U.S. dollar is weak and the U.S. national debt is at an historical high, the specter of OPEC countries dropping the dollar in favor of other currencies, while it might be a boon to Europeans, is a great threat to the U.S. economy.

A further drain on economic resources caused by imports of expensive oil could occur should supply fall sharply due to a catastrophic terror attack against the region's energy installations. Throughout the world jihadist terrorists and other rogue elements attack oil and gas installations almost on a daily basis with a growing impact on the world economy. What makes oil interesting for terrorists are the unique conditions that have been created in the oil market in recent years. Until 2002, the oil market had sufficient wiggle room to deal with occasional supply disruptions. Such disruptions could be offset by the spare production capacity of some OPEC producers, chiefly Saudi Arabia. This spare capacity has been the oil market's main source of liquidity. But due to the sudden growth in demand in developing Asia, this liquidity mechanism has eroded from 7 million barrels per day in 2002 which constituted 10% of the market to about 2 million barrels per day today, less than 3%. As a result, the oil market today resembles a car without shock absorbers: the tiniest bump on the road can send a passenger to the ceiling. Without liquidity, the only mechanism left to bring the market to equilibrium is rapid and uncontrolled price increases. This reality plays into the hands of terrorists who want to hurt Western economies. Osama bin Laden's strategy is based on the conviction that the way to bring down a superpower is to weaken its economy through protracted guerilla warfare. We "bled Russia for ten years until it went bankrupt and was forced to withdraw [from Afghanistan] in defeat. […] We are continuing in the same policy to make America bleed profusely to the point of bankruptcy," bin Laden boasted in his October 2004 videotape. Striking against oil, which jihadists call "the provision line and the feeding to the artery of the life of the crusader's nation" (Washington Post, 2004) is easy and effective. Terrorists can cause enormous economic damage by hitting energy targets at points of generation, where they enjoy strong support on the ground. Politically motivated attacks on oil pipelines in Iraq have denied the global oil market over 1 million barrels per day. Had this oil been in the market, the price per barrel would have easily dropped by $10–15. For the U.S., an importer of more than 11 million barrels a day, the terrorist premium alone costs $40–60 billion a year. Should terrorists successfully target one or more of the mega-facilities in Saudi Arabia, as they have tried to do several times, oil prices could easily climb to $150 a barrel, causing incalculable economic losses and even greater transfer of wealth to Middle Eastern governments.

6. Impact on Transatlantic Relations

To understand how dependence on the Middle East affects transatlantic relations we must first understand the difference in approach to energy security between Europe and the U.S. EU countries import much of their electricity in the shape of Russian natural gas – 40% of EU gas imports originate from Russia, 30% from Algeria and 25% from Norway. By 2030, over 60% of EU gas imports are expected to come from Russia with overall external dependency expected to reach 80% – increasingly susceptible to supply disruptions, extortion and price manipulations. So when Europeans talk about energy security they think primarily about electricity and more specifically Russian natural gas. The U.S. on the other hand, at least when it comes to electricity generation, is virtually energy independent, relying on its vast domestic resources like coal, natural gas, nuclear power and renewables, primarily hydroelectric power. Furthermore, the U.S. has almost no energy relations with Russia. Its relations with Moscow are focused on other areas of concern like nuclear proliferation, missile defense and issues like democracy promotion in Eastern Europe and Central Asia. Hence, when Americans think about energy security they think primarily about the transportation sector, 97% of which is petroleum dependent. And while only a quarter of their oil imports originate in the Middle East there is strong recognition that the region holds the keys to their economic security.

While both Americans and Europeans agree that stability in the Middle East is a prerequisite to global energy security, they differ somewhat on how to achieve it. As mentioned before, the U.S. advocates an energy policy which includes the use of military force to pacify volatile energy producing regions and secure energy supply lines. The European response to the energy challenge is less muscular. By and large, Europeans are reluctant to use military force, preferring to see market forces and economic interdependencies as the main guarantors of energy security. Some Europeans even see the U.S. militarization of energy security and its military presence in the Middle East as a disruptive factor which only builds tension and undermines energy security. Such an approach is not well received among Americans who believe that, left to their own devices, aggressive Persian Gulf dictators are likely to bully their neighbors, attempt to take over their energy resources, and disrupt the flow of oil in the Strait of Hormuz. Saddam Hussein's unprovoked attacks on Iran in 1980 and Kuwait in 1990 are a testimony that this concern is not baseless – which is why American administrations are willing to spend annually tens of billions of dollars in order to maintain the military capabilities necessary to protect Persian Gulf oil while Europe, a major consumer of Persian Gulf oil, has contributed very little to the security effort. One manifestation of the transatlantic disagreement regarding the effectiveness of the use of force is the debate on what should be the role of NATO in energy security. After years of deliberations within the alliance, NATO Secretary-General Jaap de Hoop Scheffer declared recently that "energy Security is a NATO-relevant subject," and the Alliance finally embraced in its 2007 Riga Summit energy security as one of its core issues (International Herald Tribune, 2006). But what NATO's exact role and mission should be in addressing the growing challenge is far from agreed. While the U.S. prefers that the alliance commit itself to prepare a range of options for jointly deterring the use of energy as a weapon and respond if such an event occurs, most EU members are reluctant to expand the alliance's responsibilities, expressing concern that an increased role for NATO on energy security would send the wrong signal to Russia.

Hence, European preoccupation with Russian energy prevents the EU from adopting a more militaristic approach to energy security. Furthermore, the U.S. and Europe also differ on how to achieve stability in the Middle East. By and large, Americans believe that the keys to stability in the region are social, political and economic reforms which would reduce some of the inherent domestic tensions among the region's societies. Europeans, for their part, tend to highlight the role of the Arab-Israeli conflict, holding that without reconciliation and a permanent solution to the Palestinian problem the Middle East will never be peaceful. Indeed, since the establishment of the State of Israel in 1948 the Arab-Israeli conflict has been a sore wound to Muslim societies and a recurring source of tension in the region. To be sure, even within the U.S. there are many who hold the European view. Sixty years ago U.S. Secretary of State Edward Stettinius opposed the creation of the state of Israel stating "it would seriously prejudice our ability to afford protection to American interests, economic and commercial […] throughout the area." More recently, The Iraq Study Group argued for a more aggressive U.S. role in the Arab-Israeli conflict as a way to mitigate regional tensions and stabilize the situation in Iraq. Friends of Israel in the U.S. prefer to de-link the Arab-Israeli conflict from the region's other ailments, arguing that, while being a good thing in and of itself, resolution of the Arab-Israeli conflict will have little impact on the behavior of Persian Gulf regimes and the social illnesses from which the region's population suffers. The differences of opinion regarding Israel's impact on regional stability could deepen should another war break out between Israel and its neighbors and should the Arab countries decide to use the energy weapon as they did in 1973. Many believe that the oil weapon is obsolete and will not be used again. This view may be overly optimistic in light of the fact that since September 11, several major energy exporters including Saudi Arabia, Iran, Iraq and Venezuela rattled the oil saber when tensions with the U.S. deepened. In October 2002, Mahathir Mohamad, then Malaysia's prime minister and chair of the Organization of the Islamic Conference explained: "Oil is the only thing Muslim nations have which is needed by the rest of the world. If they can cut back on supply, people will not be oppressive on them. […] It can be used as a weapon to protect the interest of Muslims" (Luft, 2003). Earlier that year, Iran's supreme leader Ayatollah Ali Khamenei warned that "if the west did not receive oil their factories would grind to a halt. This will shake the world!" To many, those statements seem hollow. However, they indicate a deepening understanding within the oil producing community, and particularly within the Muslim world which owns nearly 75% of the world's oil reserves, that the use of energy as a political weapon is a legitimate strategy. Hence, just like in 1973, the world's oil consumers could 1 day be asked to rescind their support for the Jewish state in order to ensure their energy supply. As things stand now, in such a case, Europeans would be more easily pressed to lean toward oil while the U.S. is more likely to take a pro-Israel position.

7. Conclusion

Despite the above differences between Europe and the U.S., in recent months we have witnessed an increased convergence in the trans-Atlantic dialogue on energy security. This has much to do with soaring oil prices and the decline in Norwegian oil production which makes Europe increasingly dependent for its oil on the Middle East. Hence, there is a clear understanding on both sides of the Atlantic that due to the global and strategic nature of the challenge, improving our ability to manage and conserve finite resources, diversifying energy portfolios, protecting energy facilities and building sufficient mechanisms to deal with inevitable disruptions are in the best interests of all parties. A transatlantic consensus exists for better management of strategic petroleum reserves and for strengthened energy dialogue with emerging energy consumers in the developing world, primarily China and India, with possible future inclusion of those two emerging Asian giants in the International Energy Agency regime. There is also a growing consensus on the need for diplomatic and economic support for ways to curb the Middle East's influence by developing alternative supply sources and alternative energy routes from Central Asia and Africa. But since oil is a fungible commodity which is traded in the global market, diversification away from the Middle East to other suppliers would be, at best, a stop-gap solution. As long as the world's transportation system depends on oil to the degree that it does today, dependence on the Middle East will grow and so will the economic and security burden associated with such dependency. The key should be to reduce demand for oil – period – and since two thirds of the world's oil is used for transportation this means reducing oil use through increased fuel efficiency and through a shift from a petroleum dependent transportation system to one that relies on next-generation fuels, meaning non-oil based transportation fuels such as methanol, ethanol, biodiesel, electricity and others derived from abundant domestic energy resources such as coal, nuclear power, biomass, and municipal waste. Yet, the challenge ahead is how to reconcile environmental and security considerations. Both Europe and the U.S. are well endowed with coal, yet both are reluctant to expand its role in their energy portfolio and convert coal to liquid fuels. Though nuclear energy is a near-zero emissions energy source, in both Europe and the U.S. the nuclear industry is suffering from stagnation. Germany announced that it will phase out nuclear power by 2020. In the U.S. not one nuclear reactor has been built for 3 decades and political agreement on what to do with nuclear waste is not on the horizon. This policy will have to be reviewed as electricity begins to play a bigger role in the transportation sector.

Resolving all the problems associated with the shift from oil to alternatives will take enormous effort and a long period of time. In the interim, Persian Gulf countries are becoming wealthier and more powerful than ever. This means that, at least in the foreseeable future, energy security will require careful management of relations with the Middle East. The only way consumers can check the region's influence and anti-free market behavior is by putting their collective weight together to act in a unified manner to counterbalance OPEC and bring the cartel to adopt policies conducive to energy security that are necessary to bring down oil prices: an increase in production capacity, greater openness and a more hospitable investment climate without which international oil companies will not be able to operate in the region.

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BULGARIAN ENERGETICS MANAGEMENT AND ENVIRONMENTAL SECURITY

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Abstract: The policies of the Republic of Bulgaria in the areas of energy utilisation and diversification, oil and gas transport, nuclear power plant management and regional environmental protection are presented in this paper.

Keywords: Energy diversification, nuclear energy, regional environmental protection

1. Introduction

Energy will remain one of the major issues of the 21st century, especially in Europe, given its high dependency on energy imports. Energy in general and electricity in particular are essential for economic and social development, prosperity, health and security of citizens. Energy demand continues to increase, raising concerns about supply, the economic competitiveness of different sources, and repercussions on economic and social development and the environment.

Large-scale use of gas and oil in Europe's future energy mix raises serious geopolitical concerns. Europe may negotiate with oil and gas suppliers, but the European economy will nonetheless remain vulnerable to sudden sharp rises in oil and natural gas prices.

The world population over the last 10 years has increased by more than 12%, while Europe has seen a 1.4% increase in population and is now home to 13.6% of the 6.4 billion people in the world. At the same time, global primary energy consumption, currently around 11,000 Million Tons of Oil Equivalent (Mtoe), has seen an increase of 20%, again led by East/South-East and South Asia with an increase of around 35% compared to 7.3% in Europe (World Energy Council, 2007).

Global electricity consumption, currently at about 18,000 terawatt-hours (TWh), has increased by 16% in Europe. Considering the dramatic increase in demand for electricity driven by East/South-East and South Asia (e.g. China and India) and the fact that around 1.7 billion people in the world today do not have access to electricity, there are widespread expectations of rising and volatile fossil fuel prices, compounded by concerns about security of supply from the leading primary energy resources and environmental impacts due to the extremely high growth of coal plants in liberalised markets of East/South-East and South Asia.

In 1997, the European Union (EU) signed the Kyoto Protocol, which sought to achieve an overall reduction of 8% in Greenhouse Gas (GHG) emissions during the period 2008–2012, compared to the emission levels of 1990. However, by 2002, the 15-member EU had managed to reduce its combined emissions by only 2.9%, and the current trend suggests that emissions will increase (Figure 1). Climate change is a long-term challenge for the international community, and the objectives mapped out in the Kyoto Protocol are simply the first stage. Thus, the EU recently established a 50% GHG emission reduction target for the year 2030 and an 80% reduction target for the year 2050.

In support of these commitments, and with the objective of promoting public debate, the EU published the Green Paper "A European Strategy for Sustainable, Competitive and Secure Energy" (European Commission, 2006) in March 2006. Its objectives were to guarantee security of supply, reduce the environmental impact of energy use and production, reduce energy demand through savings and efficiency and, in relation to supply, double the contribution of hydro and other renewable energy sources to 10% of global primary energy consumption by the year 2012.

Consequently, consideration should be given to all these factors, to which others of special relevance may be added, such as liberalisation of the energy markets, waste management and public acceptance of different technologies,

Figure 1. World CO2 emissions by area (IEA data in Mt CO_2, 2004): (**a**) – OECD Europe; (**b**) – OECD Asia & Pacific; (**c**) – OECD North America; (**d**) – Non OECD.

all of which have a certain impact on the energy scene. The expected exponential growth in demand for energy services, in particular in developing regions, and the global, regional and local environmental impacts resulting from the supply and use of energy will pose in the future the question – How can we supply energy for the inhabitants of Earth, sufficient to meet everyone's needs, without causing serious, irreversible damage to the environment?

2. Actual Energy Situation in Europe

As of 31 December 2004, the installed generating capacity of Europe (Figure 2) totalled 1,045 gigawatts (GW), some 599 GW (57%) of which was fossil fuel generated, 228 GW (22%) was hydro, and 172 GW (17%) was nuclear (World Energy Council, 2007).

Two thirds of installed fossil fuel fired generation capacity in Europe is now found in five countries (Russia, Germany, UK, Italy and Spain). In terms of installed nuclear capacity, France has the largest concentration (57% or 63 GW), second is Russia with nearly 22 GW, closely followed by Germany (20 GW), Ukraine (13 GW) and the UK (12 GW).

The development of low cost gas fields in the North Sea and greater sensitivity to the environment led to the development of lower-emission technologies. Investments over the last 15 years have focused on natural gas combustion and renewable resources and recently there has been considerable investment in combined cycle gas turbine (CCGT) plants. About 50% of European gas combustion capacity is in the UK and Italy (around 23 GW each). Germany has 17 GW. Natural gas constitutes 57% of the total installed capacity in the Netherlands, 41% in Ireland and 30% in Denmark.

There are very few oil-fired power plants in Europe (9% of total capacity), mostly in Italy, France and the UK. Renewable resources represent a significant share of investment and interest in terms of new capacity, but do not represent a great share in the generating mix.

Electricity generation in Europe in 2004 was around 4,402 terawatt hours (TWh). Some 54% (2,387 TWh) of this was generated by fossil fuel combustion and about 28% by nuclear power.

Historically, fossil fuels are used predominantly in electricity generation in countries with domestic fossil fuel production such as Russia (oil and natural gas), the UK (oil, gas and coal), Germany and Poland (mostly coal and lignite). A clear exception is Italy, which produces more than 75% of its electricity with imported fossil fuels.

Electricity from renewable sources in 2004 was 4% of total European generation. Germany accounted for nearly 36% of this total.

The future of nuclear power in Europe has been controversial for the past 2 decades, largely as a result of the Chernobyl accident in 1986. Following a

Country	Total	Nuclear	Conventional thermal power plants	Hydro	Other renewables
Albania	1,671	-	226	1,445	-
Austria	14,100	-	5,700	8,000	400
Belarus	7,910	-	7,830	80	-
Belgium	15,680	5,802	8,369	1,416	93
Bosnia Herzegovina	4,341	-	2,301	2,040	-
Bulgaria	9,456	2,722	4,934	1,800	-
Croatia	3,600	-	1,500	2,100	-
Cyprus	988	-	988	-	-
Czech Republic	16,028	3,528	11,500	1,000	-
Denmark	13,639	-	9,899	11	3,729
Estonia	3,340	-	3,300	30	10
Finland	16,456	2,656	10,900	2,900	-
France	111,863	63,363	26,700	21,000	800
Germany	125,431	20,003	67,015	14,604	23,809
Greece	12,224	-	9,126	3,061	37
Hungary	8,306	1,755	6,500	50	1
Ireland	4,463	-	3,701	512	250
Italy	81,511	-	59,632	20,744	1,135
Latvia	2,124	-	600	1,500	24
Lithuania	4,747	1,185	2,652	910	-
Luxembourg	500	-	440	40	20
Macedonia	1,484	-	1,009	475	-
Malta	478	-	478	-	-
Netherlands	20,289	449	19,300	40	500
Norway	28,055	-	255	27,700	100
Poland	34,053	-	33,085	880	88
Portugal	11,852	-	5,262	4,721	1,869
Romania	21,505	655	14,700	6,150	-
Russia	206,063	21,743	139,600	44,700	20
Serbia & Montenegro	9,287	-	5,798	3,489	-
Slovak Republic	7,242	2,442	3,200	1,600	-
Slovenia	2,995	676	1,318	984	17
Spain	61,960	7,585	26,941	18,572	8,862
Sweden	33,550	9,471	5,700	16,137	2,242
Switzerland	17,320	3,220	500	13,200	400
Ukraine	54,011	13,107	36,200	4,700	4
United Kingdom	76,352	11,852	61,700	1,500	1,300
Europe-37	**1,044,874**	**172,214**	**598,859**	**228,091**	**45,710**

Figure 2. Installed capacity in World Energy Council (WEC) European countries, MWe (developed by WEC Study Group with inputs from national committees and IAEA, 2004).

prolonged "out in the cold" period, there is a growing call for a re-assessment of the role of nuclear power in Europe's energy mix. The fact that nuclear energy produces virtually no CO_2 emissions, coupled with developments in technology and concerns over the increasing cost and uncertainty of oil and gas supplies, are gradually transforming nuclear power into an attractive prospect.

Europe must meet its rising energy demand without environmental damage, reducing harmful emissions and securing a stable and sustainable energy supply, and without excessive price or availability fluctuations.

Today, nuclear accounts for nearly 30% of the total electricity supply in Europe and about 45% of the world total nuclear power generating capacity is located in Europe. In the aftermath of the Chernobyl accident, a number of European countries have committed to phasing-out their nuclear capacities, and most of them have no alternative fallback solution. All future scenarios suggest that energy demand is set to grow strongly all over the world and, in particular in the large emerging economies in Asia.

Increasing competition for energy resources, above all for oil and gas, and rising energy prices are expected to change the global energy scene and Europe's role in it. Europe (excluding Russia) currently imports 50% of its energy, and this figure is expected to grow to approximately 70% by 2030. More effort should go towards harmonisation of energy policies across Europe and development of an open dialogue between energy producing and transit countries.

The European energy sector currently faces three major challenges:

- Ensuring security of energy supply
- Stabilising and even reducing GHG emissions and
- Maintaining economic competitiveness by keeping energy prices at an affordable level

In terms of its future energy choices, Europe is presently at a crossroads: more than 80% of installed capacity (currently more than 1,000 GW) will be over 30 years old by 2020. This means a large number of power plants will retire over the 2010–2030 period; it is a major challenge but also a unique opportunity, since the choices made today will be shaping Europe's energy future for decades to come.

This situation is not unique to Europe, and many countries in other parts of the world are facing similar issues. All energy resources, including nuclear, will be required to address the challenges of climate change, security of supply and high volatility of fossil fuel prices.

3. Bulgaria as a Part of the Regional Oil and Gas Market in the Balkans

Southeast Europe occupies a strategic position, exporting electricity through the Balkans and transporting Russian natural gas to Western Europe and Turkey. Bulgaria has had problems transitioning from a centrally-planned economy to a market-based economy.

Bulgaria was significantly affected by the economic embargo placed on Yugoslavia in the 1990s, suffering billions of dollars in GDP losses due to disrupted trade, transport, and investment.

Bulgaria joined the North Atlantic Treaty Organization (NATO) in March 2004 and is a member of the European Union (EU) since January 2007. In February 2005, Bulgaria announced that its energy sector was 66% privatized in accordance with EU directives. Bulgaria is working with the International Monetary Fund (IMF) to bolster its economy, showing a solid real gross domestic product (GDP) growth rate in 2005 of 5.5%.

3.1. REGIONAL OIL TRANSIT

Bulgaria is a net oil importer, depending primarily on Russia for most of its supply. While Romania has the largest oil reserves in Central and Eastern Europe and is a mature oil producing country, Bulgaria does not produce significant quantities of crude oil. Both of these countries are important transit countries for oil and natural gas from the former Soviet Union.

According to *the Oil and Gas Journal* (2006) Bulgaria had 15 million barrels of proven oil reserves in 2006. The country produced 3,000 (barrel-per-day) bbl/day and consumed 180,000 bbl/day in 2005.

Bulgaria's geographic location on the Black Sea gives it the ability to serve as a transit route for Caspian Sea oil exports headed to European refineries, as well as a transit point for Russian natural gas exports to Turkey. Oil is imported through Bulgaria's main port at Burgas, where both the oil terminal and refinery are connected by pipeline to several Bulgarian cities.

Bulgarian oil and natural gas exploration occurs predominately in the northern part of the country and the Black Sea. In January 2005, the Bulgarian government offered the offshore Shabla block in the northern Black Sea shelf under a 3-year exploration license. Potential reserves are expected at 200 million barrels. In 2006, the Bulgarian government extended the permit of the Pleven-based Oil and Gas Exploration and Production Company by 2 years to explore for oil and gas in the Pleven region of northern Bulgaria. Melrose Resources (Melrose) began its latest offshore Bulgarian oil and gas search in September 2004. In 2006, Melrose received an extension of its permit for the offshore block Emine, and also signed a 25-year concession agreement to develop the Galata offshore field, which has estimated reserves of 53 Bcf.

Bulgaria's biggest oil refiner, Lukoil's Neftochim, has a nameplate capacity of 140,000 bbl/day. The facility processed roughly 129,000 bbl/day of crude in 2005, up 13.7% from 2004. The company invested $62 million in reconstructing and upgrading its assets and in the construction of new facilities in 2005, in addition to $45 million invested the previous year. Lukoil Neftochim recently began producing fuels under the European emission standard Euro 3 and plans to upgrade its facilities to the more difficult Euro 4 standard.

Lukoil has stated that it will invest around $1.0 billion in the development of its oil refinery and retail network in Bulgaria up to 2011.

Located on the western shores of the Black Sea, a major route for world oil exports, the countries of Southeastern Europe hope to grow as transit centres, carrying Russian and Caspian Sea Region oil to market in Europe. Several pipelines are currently in various stages of construction and development.

Because oil exports from the Caspian Sea region are projected to increase rapidly in the next decade, several oil pipeline proposals to bypass Turkey's increasingly congested Bosporus and Dardanelles straits are under consideration or in development (Figure 3). The following are projects passing through Southeast Europe, although there are other projects proposed that would relieve tanker traffic such as reversal of the Brody-Odessa pipeline, the Adria pipeline/Druzhba integration project, and the Samsun-Ceyhan pipeline.

The 570-mile, 750,000 barrel-per-day (bbl/day) Albania-Macedonia-Bulgaria (AMBO) pipeline will connect the Bulgarian Black Sea port of Burgas with the Albanian Adriatic port of Vlore, allowing seaborne oil exports from Russia and the Caspian Sea region to flow overland between the Black Sea and the Adriatic. In December 2004, AMBO announced that front-end engineering and design (FEED) on the $1.5 billion pipeline would be completed in early 2005, following the December 28, 2004 signing of a memorandum of understanding (MOU) by ministers from Bulgaria, Albania, and Macedonia. Construction has not started yet.

In January 1997, Bulgaria, Greece, and Russia agreed to build the $700 million Burgas-Alexandroupolis oil pipeline linking the Bulgarian Black Sea port of Burgas with Alexandroupolis on the Mediterranean coast of Greece (see map). As originally conceived, the proposed 178-mile underground

Figure 3. Balkan oil transit pipelines projects.

pipeline would allow Russia to export oil (up to 300,000 bbl/day) via the Black Sea, bypassing the Bosporus. The project was stalled for several years by a wide range of technical and economic issues. Although Russia, Greece, and Bulgaria signed a memorandum on the commencement of pipeline construction in November 2004, the countries did not complete a MOU by the end of the year due to Russian's support of AMBO as an alternative to the Burgas-Alexandroupolis pipeline. Greece continued to lobby for construction of the pipeline, and the final MOU was signed in April 2005.

In 2006, Russia was granted a 51% stake in the pipeline project. In response, the Bulgarian state-controlled gas monopoly Bulgargaz and the Universal Terminal Bourgas (UTB) proposed to co-create a Bulgarian corporation that will control a minimum 24.5% of the remaining 49% of the Bourgas-Alexandroupolis oil pipeline. Greek candidates have created the Thraki Company for the purposes of the project. It is as yet unclear when the project will start in fact.

The Constanta-Trieste oil pipeline proposal entails development of a pipeline connecting the existing Romanian Black Sea Port of Constanta with Italy's Adriatic port city of Trieste. The Romanian-proposed crude oil pipeline, also known as the Pan-European Oil Pipeline, will extend across Romania to the Serbian town of Pancevo where it will connect to an existing branch of the Adria pipeline that runs from Pancevo to Trieste. At Trieste, the pipeline will connect with the Trans Alpine Pipeline (TAP) that connects northern Italy with Austria and Germany.

In May 2006, ministers from five countries endorsed a MOU to start the $2.3 billion project. The deal confirms the participation of Italy and Slovenia with existing partners Serbia-Montenegro, Romania and Croatia on the 870-mile pipeline. The largest portion of the pipeline (400 miles) will be in Romania, which will incur $1.2–2.1 billion of the total project costs. The capacity of the pipeline will be between 800,000–1.8 million bbl/day and would be operational by 2011–2012.

3.2. NATURAL GAS TRANSIT

Southeast Europe has little natural gas production, but it is an important transit centre for Russian natural gas to Western Europe (Figure 4).

The majority of Russian natural gas piped to Bulgaria through the Progress pipeline moves on to other markets. The two countries expect the volume of transit gas to grow to 740 billion cubic feet (Bcf) by 2020, up from 137 Bcf in 2004, as a result of Gazprom pledges to invest in Bulgaria's natural gas infrastructure. In August 2004, Bulgarian natural gas company Overgas, Dor Gas Elran Infrastructures, and Africa–Israel Investments signed an agreement to build a larger gas transportation network in Bulgaria. Construction of a

Figure 4. Natural gas transit in SE Europe.

main natural gas pipeline and smaller distribution pipelines to supply half of Central Bulgarian households will take approximately 4 years.

Gas consumed domestically in Bulgaria is imported primarily from Russia at highly subsidized prices, in exchange for Russia's use of Bulgaria as a transit country. However, Russia recently expressed interest in paying transit fees in return for Bulgaria paying the market price for its natural gas. This could significantly reduce Bulgarian gas usage. Bulgaria is currently searching for ways to decrease its dependence on Russian gas supplies. Melrose's output is expected to rise to as much as 141 Bcf/year. This increase in production could lead to near self-sufficiency for the country in the future.

A number of pipeline projects are planned in Bulgaria to increase natural gas transport capacity. One of them is the Nabucco project, launched in 2002, which entails the construction of a pipeline from the Caspian Sea region to Western Europe, bypassing Russia. Negotiations concerning the Nabucco project between the natural gas companies of five countries – Bulgaria's Bulgargas, Romania's Transgas, Turkey's Botas, Hungary's MOL, and Austria's OMV – concluded in June 2006, when the Nabucco Company Pipeline Study Group was formed to undertake construction of the natural gas pipeline network (Figure 5).

The Nabucco project aims to transport natural gas from the Caspian Sea and Central Asia, including Iran, Azerbaijan, Turkmenistan, and Kazakhstan, to the countries of Central and Eastern Europe.

The project has received widespread support from the EU since the project would lessen the region's dependence on Russian gas. Construction

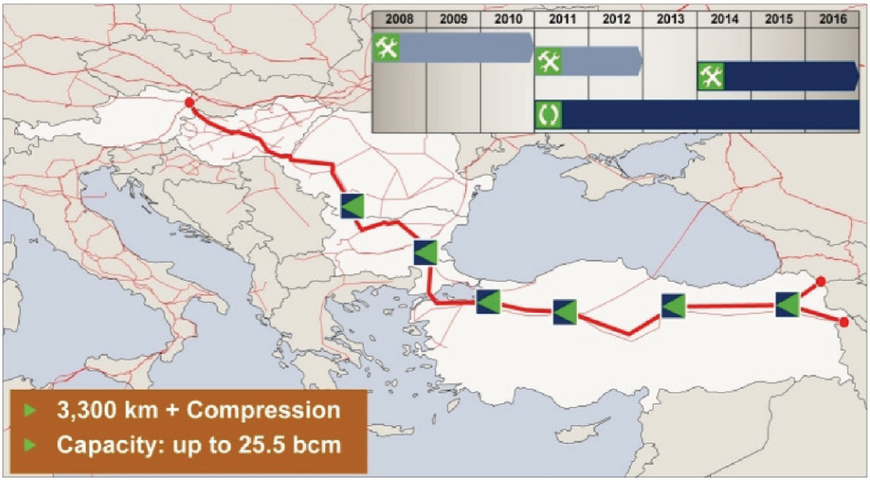

Figure 5. Nabucco project.

of the 1,760-mile, $5.8 billion pipeline is set to begin in 2008 and end in 2011. It will have an annual capacity of 170–480 Bcf.

3.3. BULGARIAN ENERGETICS TODAY

Bulgaria produced 42 billion kilowatt hours (Bkwh) of electricity in 2004. The country has 64 hydropower plants, with 2,700 MW of installed capacity, accounting for 19% of the country's overall generation. In April 2004, Bulgaria and Austria began construction of the 85-MW Tsankov Kamuk hydropower plant on the Vacha River, scheduled for completion in 2009.

Bulgaria expected to fully liberalize its electricity market by 2007, in adhering to EU standards. The government privatized seven power distribution companies, selling them to the Czech Republic's CEZ, Germany's E.On, and Austria's EVN in 2005 for a total of $827 million. In 2006, Bulgaria's Privatization Agency (PA) signed a draft contract to sell the 1,260-MW Varna power plant to Czech utility CEZ for $250 million, after Russian utility company UES withdrew its $689 million offer earlier in the year over regulatory and environmental issues. CEZ has also pledged to invest another $140 million in the power plant.

4. Bulgarian Nuclear Energetics and Environmental Security

Global energy demand is set to rise substantially during the 21st century. This expectation is based on three factors – the drive to raise living standards in the developing world, continued population growth, and economic expansion and greater industrialisation that improve the standard of living but require additional energy.

In Bulgaria as elsewhere the energy sector is one of the main polluters of the environment. The main energy sites in Bulgaria have been originally located on the basis of norms which existed some time ago and were common for the member countries of the former Council for Mutual Economic Assistance (CMEA). At present, Bulgaria has signed documents of the European Union relating to the control of harmful emissions, and taking into consideration the country's existing and rather dated technological base, gradually it is expected to adhere to emission limits which can realistically be achieved.

While the demand for electricity is growing faster than energy demand, fossil fuel combustion is recognised as a major cause of environmental damage. The release of greenhouse gases from burning coal, oil and gas is seen as a major contributor to global warming. Projections for the future role of nuclear power in this context vary widely depending upon the assumptions. These different assumptions highlight factors influencing the future of nuclear power, and so it is useful to examine a few such issues.

Six units with a total electrical capacity of 3,760 MW have been installed in Bulgaria's nuclear power plant Kozloduy (Gramatikov, 2005). The Kozloduy NPP has allowed the country to become the fourth major energy exporter in Europe, with the Bulgarian national electric company, Natsionalna Elektricheska Kompania (NEK), exporting 7.0 billion kilowatts (Bkw) of electricity in 2004. Kozloduy produced more than 40% of Bulgaria's electricity in 2004. Reactors 1 and 2 were decommissioned in December 2002, and Bulgaria's electricity export potential shrank. Bulgaria also agreed with the EU request to shut down nuclear reactors 3 and 4 as of January 1, 2007. After the closure of these units, only reactors No. 5 and No. 6 are in operation, generating an electricity shortage for the country and forcing it to significantly reduce electricity exports. In April 2006, the Bulgarian economy and energy minister announced that the direct losses to Bulgaria will be over \$2 billion with the closure of the two units. Bulgaria received \$688 million from the EU as compensation for the closures.

In January 2005, Bulgaria announced plans to have its second nuclear plant, Belene, operational by 2011 to offset the loss of the two reactors at the Kozloduy facility. Design and construction will be supervised by Parsons Europe Ltd, while Italian energy utility Enel plans to hold a majority stake in the 2,000 MW nuclear power station. It is estimated to cost between \$3–5 billion and will be built along the Danube.

In Bulgaria there is a developed national system for radiation monitoring providing constant measurements of radiation levels. The measurement results confirm that Kozloduy NPP has practically no environmental impact. Values of the radiation levels are shown in Figure 6.

Figure 6. Average values of current radiation gamma-background in Bulgaria for the last 24 h at 09:00 on 18 October 2007. For the territory of the Republic of Bulgaria the natural gamma-background is from 0.06 to 0.60 µSv/h.

The amount of hazardous waste generated in Bulgaria in 2003 was 73% of that generated in 1999. Expenditure on protection and restoration of the environment was 570 million Bulgarian Levs in 2003, which was 17% higher than in 2002. This amounted to 1.7% of GDP, compared to 1.5% the previous year (Catalogue of Statistical Publications, 2005).

The areas with the highest share of these resources in 2003 include: protection of water resources – 31.2% (25.9% in 2002), air protection – 22.8% (17% in 2002), and detoxification of waste – 20.1% (23.8% in 2002). The share for protection of soil and forests is respectively 3.2% and 1.8% of the total expenditure in 2003. At the end of 2003, the tangible fixed assets were 1,133 million Levs (926 million Levs in 2002) representing an increase of about 30%.

The Kozloduy NPP contributes to air quality on the Balkan Peninsula. If the electricity generated by Kozloduy NPP in 1 year was produced by thermal power plants, it would result in an additional emission of 27 million tons of CO_2, 1.2 million tons of SO_2, 78 million tons of NO_x and about 52 t of dust containing toxic mixtures and natural radionuclides.

In order to fulfil the obligations to preserve the environment and reduce emissions of CO_2, SO_2, NO_x and ashes (Kyoto Protocol), Bulgaria plans to continue to rely on nuclear energy and to develop it according to the current requirements for nuclear safety, radiation protection, efficiency and reliability of operations. Nuclear safety in Bulgaria is evaluated according to the EU's policy document Agenda 2000 and Western European Nuclear Regulator's Association (WENRA) requirements.

5. Conclusions

Like any energy technology, nuclear will have no future if it cannot compete in the market. In many European countries, nuclear is competitive without special support. For the main part of the existing European fleet, the production cost is below €20/MWh considering that almost all the plants have been fully depreciated. Such good economic performance promotes life-extension and capacity increase for the majority of existing plants. European countries, and the EU Member States in particular, must seriously consider including the nuclear option in their energy policies. This also includes improving public awareness about energy issues, providing factual information and conducting comprehensive and efficient communication campaigns.

The following basic conclusions could be made:

1. All energy technologies have their advantages and drawbacks, and in the European context, in particular, given Europe's high dependency on energy imports, nuclear energy should be considered as an integral part of a feasible and already available solution to address climate change and security of supply.
2. Given nuclear power's excellent operational safety record in Europe, during the past 5 decades, public concern in many countries today is shifting from operational risks to nuclear waste management.
3. Decommissioning of old plants is already included in the full operational cost cycle and has a certain impact on waste management, depending on the size and the number of reactors.
4. With respect to the Bulgarian NPP Kozloduy the main issues are solved in accordance with Bulgarian legislation and international standards and the main goals are achieved to assure nuclear safety and radiation protection.
5. The radiation impact of Kozloduy NPP on the atmosphere, the waters, soils, plant and animal world and protected territories, as well as risks to the environment and the health of the population in the controlled zone are insignificant.
6. All recommendations related to the regulatory regime in Bulgaria were adequately addressed and no further monitoring of the regulatory system of Bulgaria by the EC is necessary.
7. Continuous interaction between researchers and managers is important to address issues related to nuclear safety and efficiency.

8. Nuclear energy can be used to ensure energy security, without compromising environmental security.

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SECURITY CONCERNS IN THE MIDDLE EAST FOR OIL SUPPLY: PROBLEMS AND SOLUTIONS

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Abstract: Holding 65–70% of the world's oil reserves, the Gulf States (Saudi Arabia, Iran, Iraq, Kuwait, UAE and Qatar) are key countries for the solutions to the energy supply matters of the world. The free flow of oil to world markets from the Gulf region is an integral part of international security. The Middle East has had mainly security related problems such as Arab–Israeli wars and conflicts, Arab–Iranian wars and conflicts, Arab–Arab wars and conflicts, US–Gulf wars and conflicts and, more recently, radicalism and terrorist attacks. Energy supply security requires the enhancement of peace and cooperation between countries instead of competition. Preventive policy approaches are more suitable to address energy supply matters. A preventive strategy might be possible with the active participation of NATO within the "out of area" type operations in the Middle East and quite possibly indirectly in the Asia-Pacific regions. Religious and ethnic radicalism and terrorist attacks have also had direct effects on oil supply security matters.

1. Introduction

The world's oil reserves are concentrated in the sedimentary basins of the Middle East located in the Gulf States (65% according to OPEC 2003 data or 70% according to USGS, 2000). Gulf States producers accounted for 24.7% of world oil supply in 2005 (IEA, 2005) and Gulf producers are expected to provide 51.8% of world production in 2030 (IEA, 2004). Therefore, oil from the Gulf States is very important to the United States', the European Union's and the Asia-Pacific region's energy supply strategies (Cheney, 2001; APERC, 2003; EU, 2002; Van der Linde et al., 2004). Global oil demand will rise from today's 84 million barrels per day (mbd) (IEA, 2005) to 121 mbd in 2030 according to 30-year energy requirement projections (IEA, 2004). North America will import 75% of its total oil in 2020 (Cheney, 2001), the

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EU will import 90% of its total oil in 2030 (EU, 2002) and Asia-Pacific oil dependence will also rise to 78% in 2020 (APERC, 2003).

Oil supply from sedimentary basins of the Gulf region to world markets involves basin analysis and petroleum exploration, drilling and production, and transportation, which require a climate conducive to science, engineering, technology and investment (political and economic stability). In practical terms, petroleum basins and transportation routes must be secure. Energy security is commonly defined as a reliable and adequate supply of energy at reasonable prices (Bielecki, 2002). Uninterrupted oil supply is an important peacekeeping and economic progress factor worldwide and is possible only if the energy supply is secure. The aim of this paper is to identify the security issues related to oil supply from the Gulf region and to offer solutions.

2. Security Problems for Oil Supply in the Middle East

There are several security elements affecting the continuous flow of oil from the Gulf region.

2.1. INTERNATIONAL COMPETITION

The competitive pursuit of petroleum in the Middle East began among Turkish, German, British and French businessmen, statesmen and spies alike in the late 19th century Ottoman Empire. After World War I, oil competition continued among Turkish, British, French and American interests. While Turkey and France were driven away, the US and UK continued in their pursuit of oil in the Gulf region (Yergin, 1993; Usumezsoy and Sen, 2003). The cold war divided competitors into the NATO and Warsaw Pacts. After the cold war period, France, Russia, and China began to compete with the US and the British for oil in the Gulf. Despite US and UN economic sanctions, France, Russia and China have invested in both Iran's and Iraq's energy and defense sectors (IEA, 2001; Klara, 2001). One of the reasons for doing so was the oil riches of Kuwait, which was invaded by Saddam Hussein.

In the past few years, oil has made a spectacular return on the international agenda. Major consumer countries are deeply concerned again about their future security of supply (Cheney, 2001; CSIS, 2000, 2002; Horsnell, 2000; Andrews-Speed et al., 2002; Ogutcu, 2003; EU, 2002; APERC, 2003; Van der Linde et al., 2004; Correlje and Van der Linde, 2006). The US–Iraq war (second Gulf War) is much more related to oil supply rather than weapons of mass destruction (WMD) allegations (Usumezsoy and Sen, 2003). The destabilization effect of WMD and related technology transfer such as the Iranian nuclear program has also contributed to a perception of serious regional risks and higher prices. From this crisis basically multinational oil firms and Russia will be the apparent benefactors. In fact, the second Gulf War has seriously disrupted oil supply from Iraq and has caused a new oil shock (Sen, 2004) from which multinational oil firms and Russia are again the primary beneficiaries.

High oil prices yielding high oil revenues for the Gulf States are also directly affecting international competition and the security of the whole region. For instance, recent discussions on whether oil revenue transfers should be made with petro-dollars or euro-dollars are getting much more serious, destined to have wider repercussions in the security field as well. In addition, under effective pressure from the international community, Iran is becoming inclined to use high oil prices as a weapon, with open threats to cut oil supply and to use some oil revenue to support terrorist activities against Israeli and western interests.

2.2. WARS AND CONFLICTS IN THE MIDDLE EAST

2.2.1. Arab and Israeli War and Conflicts

The establishment of the Israeli state after World War II gave rise to several wars between Israel and the Arab world. These wars seriously hindered oil supply from the region. Firstly, the establishment of Israel led to the shutdown of the Mosul (in Northern Iraq) – Haifa oil pipeline in 1948. Jamal Abdel Nasser, then president of Egypt, closed the Suez Canal after the Israeli–Arab war in 1957. The first oil shock was felt when the Arab oil producers put into practice an oil embargo against the US and Europe after the Arab–Israeli war of 1973. The Arab–Israeli war over Beirut led to the closure of the Tapline (Trans-Arabian Oil Pipeline) in 1983, which is used to transport oil from the Gulf to the Mediterranean. Some terrorist attacks are also related to the Arab–Israeli conflict. For example Hezbollah, Islamic Jihad, Hamas and the Palestinian Liberation Organisation (PLO) have emerged as reactions to Israeli operations. More recently, Al-Qaeda quite often mentions the Arab–Israeli conflict as one of its excuses or justifications for terrorist attacks.

2.2.2. Iran–Arab and Arab–Arab Wars and Conflicts

The Iraq–Iran war caused a decline in oil production and serious fluctuations in the oil market beginning in the 1980s due to many reciprocal attacks on oil fields, oil infrastructure and oil tankers. During the 1980–1988 ‘tanker war’ between Iran and Iraq, there were 543 attacks on ships, with approximately 200 merchant sailors killed. More than 80 vessels were sunk or written off, causing more than $2 billion in losses and a 200% increase in global hull insurance rates (Daly, 2006). The Shatt-ul-Arab waterway was one of several points of conflict in the Iraq–Iran war. The Abu Musa, Greater Tunb and Lesser Tunb islands gave rise to many of the problems between Iran and the UAE. Disputes over the Warba, Bubian Islands and Rumaila oil field led to the invasion of Kuwait by Saddam Hussein in August 1990, which triggered the first Gulf War in 1991. Saudi Arabia has yet to reach an agreement with its neighbors over the exact location of key interior boundaries. The establishment of exclusive economic zones in accordance with the UN Convention on the Law of the Sea has also produced disagreement over the location of the Gulf's offshore boundaries (Ari, 1999; Klara, 2001; Lesser, 2000).

2.2.3. US–Gulf Wars and Conflicts

After the revolution of 1979, Iran–US relations became adversarial. The present status of Iran–US relations is poisoned again as a result of crises around Iran's nuclear program and Iran's support for international terrorism. The invasion of Kuwait by Saddam Hussein in August 1990, which triggered the first Gulf War in 1991, resulted in the serious destruction of Kuwait's oil fields. The Iraq–Saudi Arabia oil pipeline (IPSA) was closed in the first Gulf War. Starting from April 2003, Iraqi oil infrastructure has continued to be damaged throughout the second Gulf War, the effects of which are still unfolding. The second Gulf War ended in a relatively short time and Saddam's dictatorial regime afterwards collapsed. Unfortunately, after the war, reconstruction of the country and restoration of law and order in Iraq could not be achieved because the security challenges in the country could not be overcome.

Following the 9/11 terrorist attacks, US–Saudi Arabia relations were damaged by the unfolding of information on Saudi support for terrorist organizations. Although Saudi Arabia was part of the liberator coalition during the first Gulf War, the richest oil country in the world has not supported the second Gulf War, not permitted its territory to be used by US soldiers and not produced extra oil for world markets.

2.3. SECURITY MISTAKES

The Gulf States were occupied by the British military until 1971. After the British military forces withdrew from East of the Suez, the US applied the "Surrogate Strategy", a policy of utilizing friendly local powers to serve as guardians of Western interests against Soviet intervention. Substantial US military assistance was given to the three key pillars of the Surrogate Strategy, namely Iran, Saudi Arabia and Israel. Through this strategy, the US sold $20 billion worth of arms to Iran between 1970 and 1978 (Klara, 1985). Though the Iranian revolution brought an end to this strategy, the US, in response, established the Rapid Deployment Force (RDF) for direct intervention in the Gulf region in 1980. In 1983, the RDF was reconstituted under the US Central Command (CENTCOM). The year after the 1979 revolution, Iran, well equipped with modern US arms, began to fight with Iraq, which continued until 1988. During this period, Iraq was supplied with French and Soviet weapons. Then came the invasion of Kuwait by Iraq in 1990 (Klara, 2001). Later, the Gulf War began between the US led coalition forces and Iraq. On the other hand, although the Surrogate Strategy stopped with Iran's revolution, it continued in Israel and more weakly in Saudi Arabia. Intelligence ties between the US and Saudi Arabia may have indirectly contributed to the formation of the Al-Qaeda terrorist organization (Rashid, 2000). Following the 9/11 terrorist attacks, the US adopted a pre-emptive strike strategy and launched the second Gulf War against Iraq. However, these strategies, quite contrary to their original aims, have increased chaos in the region, damaged the energy supply chain and its security, and produced more violence resulting in more terrorism.

In the current nuclear program crisis with Iran, China is supporting Iran in both a military and political sense. Iranian weapons aimed to defend the Strait of Hormuz are supplied by China which deems Iran as crucial for its own secure oil supply (Ogutcu, 2003). The national interests of these two countries do not coincide with the requirements of global oil supply security, which dictates disarmament of the Strait of Hormuz through which 15.5 mbd of oil sails to the world market (IEA, 2005).

3. Solutions

It is clear that international competition, wars and conflicts, mistakes made in security enhancement and radicalism leading to terrorist acts in the Middle East are affecting the oil supply and require immediate and long lasting solutions rather than short-term limited improvements. The following possible solutions should be given serious consideration.

3.1. ENHANCING COOPERATION

Competing powers have struggled with each other since the discovery of oil in the Gulf. However, competition is not coalescing with energy supply and does not enhance it, because it includes clashes, conflict and war that can lead to the breakdown of the supply chain and higher prices. Therefore, energy supply security requires cooperation instead of competition. It is far better for the concerned parties (states-importers, exporters and multinational firms) to come together rather than staging fierce competition and conflict, tolerating the disutility or hardship caused by the guerrilla/terrorist aggression. Avoiding the prisoner dilemma (Tullock, 1974) is to realize co-operation, which is in the interests of the societies and the players themselves. Nevertheless, the groups are still competing and fighting one another despite the fact that co-operation has its lucrative payoffs.

Correlje and Van der Linde (2006) suggest two scenarios explaining conflict and competition regarding oil supply: (a) Markets and Institutions and (b) Regions and Empires. Under the Markets and Institutions scenario it is assumed that there is a continuation and intensification of the current internationalization of markets (globalization), and enduring co-operation in international security (UN Security Council, NATO), and political (UN, EU) and economic (IMF, World Bank, WTO, IEA) institutions, leading to the continued evolution of the multilateral system that governs international relations.

In the Regions and Empires scenario, the world is broken up into more or less integrated political and economic blocs with satellite regions that compete for markets and resources with other blocs. After the 9/11 terrorist attacks on the US the search for a region and empire scenario in the Gulf States gained momentum. This scenario is defined as an empire type order that controls the oil rich Gulf region (also the Caspian Basin) stemming from geostrategic imperatives for American primacy (Brzezinski, 1997). But, these storylines caused Trans-Atlantic cleavage, chaos and a new oil shock in the Gulf region (Barnet, 2004).

Although the Market and Institutions scenario is a much more suitable approach for oil supply, Empire order and Trans-Atlantic cleavage due to the Regions and Empires scenario have created a non-integrated gap in the Gulf region. According to Barnet (2004), transformation of these non-integrated gaps requires a robust connection with a functioning core which includes political rules, laws and free market rules similar to existing systems in the US, Europe and Japan.

3.2. ENHANCEMENT OF PEACE

3.2.1. Enhancement of Israeli–Arab Peace

The signing of a peace treaty between Israel and Egypt, the collapse of the Soviet Union and the invasion of Kuwait by Saddam Hussein have deeply affected Israeli–Arab relations. The end of the cold war weakened anti Israel–US regimes in the region. The first Gulf War intensified ties between Israel and Kuwait, Bahrain, Qatar and the UAE. Since the first Gulf War, Israel signed a peace agreement with Jordan to stop the Intifada, a movement which had a positive global effect for the Palestinian cause (Davutoglu, 2003). While Israeli–Arab peace efforts began in Europe with the Oslo and Madrid summits, they continued in the US with the Camp David summit in 2000. If the interrupted Israeli–Arab peace process develops further, the US believes that it is likely to improve the American political and strategic position in the Gulf region (Khalilzad et al., 1997). An improvement in the peace process between Palestinians and Israel will be for the common good and favor much needed religious tolerance and international support. One view presented by Bahgat (2005) is that control of Iraq and economic cooperation between Israel, Iran and the Arab states particularly with energy transfers may provide an opportunity to achieve a comprehensive peace in the region. Oil and gas transactions between Israel and the Gulf States should be encouraged and constructed step by step, simultaneously with the advancement of the peace process.

3.3. ENHANCEMENT OF IRAN–ARAB AND ARAB–ARAB PEACE

Two Gulf wars (Iran–Iraq war and the first Gulf War), along with numerous lesser crises, highlight the centrality of the conventional attack and defense of territory in regional conflicts (Lesser et al., 1998). Many promising sources of oil in the Gulf region are located in inhabited border zones which are poorly defined, or in disputed offshore regions. For Arab–Iranian and Arab–Arab peace, resolution of border disputes and related problems must become the focus of the attention for oil supply security matters. To this end, active UN involvement must be achieved.

3.3.1. Enhancement of US–Gulf Peace

After the Second Gulf War in Iraq, pseudo-democratic elections were held. Aside from Shi'ites and Kurds, other ethnic religious groups like Sunni Arabs and Turcomans isolated themselves from the democratic process due to security problems and their opposition to the US invasion. As an effort to change the demographics of the oil-rich city of Kirkuk, which is known as a predominantly Turcoman city, large numbers of Kurdish people were settled in the city and cast votes illegally. As a result, Sunni Arabs and Turcomans were not properly represented in the government. Even the Sunni participation in the December 17, 2005, elections in Iraq did not create much hope in terms of equal and fair representation of all ethnic religious groups in the next Iraqi government. Although Kurdish terrorist groups like the PKK are finding safe-havens in Northern Iraq, there has not been any action until now, neither from the Coalition forces nor the Iraqi authorities, to dismantle them.

Efforts in some local and international circles to establish an independent Kurdish state in Northern Iraq would also create a very risky and delicate situation for regional peace and stability as well as for the future uninterrupted supply of oil from the region. If such developments were to occur, there is the possibility of a larger clash in Northern Iraq involving Turkey, Syria and Iran, which all have substantial Kurdish populations. An enhanced federal and/or semi-independent status to be granted to Kurdish groups living in the north would inevitably result in undermining the rights and proper representation of Turcomans and other ethnic groups living in Northern Iraq. Arabs also would not accept such a development in the long run. Thus a long term destabilization effect of ethnic (Iranian, Arab, Kurdish and Turkoman), regional and religious (Sunni and Shi'ite) conflicts could persist and spread out from that part of the region in a similar fashion to the Afghanistan civil war (Roy, 1995; Rashid, 2000). Even though there are some attacks reminiscent of civil war, like suicide bombings and assassinations targeted at Iraqis rather than coalition forces, oil supply could be seriously interrupted in such a situation and oil prices could rise to an historical high resulting in an extreme oil shock (Usumezsoy and Sen, 2003).

Iraq has held two general elections since the end of the US-led war of March 2003, but its estimated 23 million people have yet to see a peaceful resolution to the sectarian strife that plagues the mainly Arab oil-producing state. Therefore, a united and integrated democratic country in which all segments and ethnic groups are fairly represented in a democratically elected government would be the best option for ensuring secure oil supply from Iraq. Iraq's natural resources should belong to its entire people, not to any one ethnic or religious group. Any effort to maintain this principle would also be a contribution to the security of oil supply from Iraq.

In order to reinstate normal relations between the US and Iran, Iran must stop uranium enrichment, its long range ballistic missiles program, and providing support to terrorist groups, and be as transparent as possible in its relations with the International Atomic Energy Agency (IAEA). As widely discussed, there are a number of possible reasons why Iran would want to acquire nuclear weapons, such as (a) national pride, (b) strategic posture in the region, (c) instability in the Gulf and the region and conventional military inferiority, (d) deterrence of the US in the face of US statements on military action and regime change, (e) deterrence of Israel, (f) nuclear sandwich of Iran by Pakistan, India, Russia, USA in the Gulf, and Israel, (g) lessons from the Afghanistan, Iraq, and Gulf wars, (h) the impact of US conventional superiority, (i) the threat of Sunni Islamic extremism, and (j) the cause of Shiite Islamic extremism (Cordesman and Al-Rodhan, 2006). Therefore, the incentives for having a nuclear and long range ballistic missile program in Iran are to deter any attack and/or to attack. US–Israeli and Iranian relations have been deteriorating since the nuclear program was restarted by President Mahmoud Ahmedinejad and since his comments about Israel and the Holocaust. However, the recent escalation in the crisis and Iran's announcement that it enriched uranium, successfully becoming the 8th nuclear power in the world, is a direct and very serious threat to the security of the world energy market (Sen and Babali, 2007).

Accordingly, in an immediate response to this escalation, oil prices have soared with the possible risk of armed conflict between Iran and the US and the UN embargo on Iranian oil exports. The US and UK pursued a solution to the crisis through the UN Security Council. On the other hand, Russia and China have expressed reservations and opposition to the US and UK proposal. As discussed in the need for a new security system section, the UN Security Council may not be able to resolve the crisis. Keeping in mind this example, mechanisms where NATO is involved or provides guidance and/ or Asia-Pacific oriented organizational and coordinated approaches for the resolution of similar crises must be developed.

3.4. CONSTRUCTION OF A NEW SECURITY SYSTEM

Security is a very important issue for the stability of the Gulf region and the flow of oil to world markets. A well considered and constructed security system might be instrumental to prevent adversarial competition, conflicts, religious radicalism and terrorist attacks. The Gulf security system is affected by internal and external elements. The Surrogate Strategy is not suitable for oil supply security simply because it causes further instability by creating unbalanced powers. RDF or US CENTCOM approaches also do not fully address Gulf security needs because security in the Gulf has become more complex and integrated. Furthermore, since the invasion of Iraq, it has become clear to all concerned parties that the pre-emptive strike strategy is not a solution to security and stability problems for the oil rich region, simply because war and conflict create a vicious circle and further increase chaos, radicalism and terrorism in the Gulf region. Therefore, there is a necessity to adopt new approaches and strategies particular to this region. The solution might be a mid-term preventive strategy with a practical, deterrent and effective power balance constructed between Israel, the Arab States and Iran. To this end, the weak Arabian security system should be supported by security strengthening policies and, to some degree, international guarantees against aggressors by the oil importing developed countries from the Gulf region, while the strong Iranian and Israeli security systems should be contained by the same mechanisms. In addition, the issue of gradual disarmament of the Gulf region should also be on the agenda as a measure for oil supply security. This ambitious, although precautionary process, as mentioned above, should begin with the disarmament of the Strait of Hormuz, the most important oil checkpoint in the world. The EU's Mediterranean dialog process, NATO's partnership for peace programs or other cooperative mechanisms applied to out of area countries and US and G-8 sponsored Greater Middle East & North Africa initiative mechanisms might be instrumental in this regard. If this inclusive and integrated organizational group approach is not adopted and the Gulf region's political, social and economic problems are not addressed in their totality, stability that will facilitate oil supply security in the region will not be achieved in the foreseeable future.

As mentioned above, the UN Security Council, even if and when reformed, will not be a suitable venue to address these issues because the interests of oil importing and exporting countries are not properly represented in the Council. The process that led to the second Gulf War is clear evidence in support of this argument. Therefore, the US–UK should give up the "empire" type unilateral order-bringing approach which follows the "Regions and Empires scenario," and must repair the cleavages within the Trans-Atlantic region through adopting a more multilateral approach and by listening to their allies. In addition, China and Japan as importing the greatest volumes of oil from the Gulf Region should come up with more cooperative approaches and concrete proposals that make net contributions to the oil security issues both in policy and material terms.

3.5. THE FIGHT AGAINST RADICALISM AND TERRORISM

In order to fight against radicalism and terrorism one has to understand the mentality of the radical and terrorist groups and their state sponsors acting with similar motives which are very common in the Middle East. For ordinary radical and terrorist group members, the benefits to be expected from overthrowing a sitting government are for the public good: the government which will take over is in some vague sense 'better' than the previous one. In following this goal, he/she will have to compare the risks to be faced by participating in a revolution and/or terrorist act which may include loss of life. Hence, the incentives to participate in such an uprising are zero for the common man or woman. For a member of a small distributional terrorist or radical coalition the incentives are almost exclusively private. Taking over the government will secure good positions and incomes for the inner circle pulling off the revolution or coup. Often the risks involved are small as well, particularly as those attempting the coup or attack are already a part of the ruling establishment and have good access to information with respect to the strengths and weaknesses of the incumbent president. In such cases, coups or regime changes tend to be quick, bloodless affairs. Basic to each of these approaches to a revolution or terrorist attack is an assumption of limited rationality. Societies and individuals – most of the time educated intellectuals – it is suggested, tend to get trapped within institutions that are not necessarily optimal, in the sense that most of the society's members would prefer some alternative structure. When a violent act or change does occur, the leaders of the terrorist group or revolt may perhaps be considered to be acting rationally since their expected gains may outweigh the costs they bear (Tullock, 1974). As for their followers, however, these theories would suggest that most are acting non-rationally and motivated by ideology since the cost of their contribution is likely to outweigh its marginal impact on their own well-being.

4. Conclusions

Gulf oil supply is the key to a robust world economy and its growth. Security of this oil supply and its unhindered free flow to world markets is vital to the stability of the Gulf region and of the oil importing countries of the world. A Market and Institutions scenario is much more suitable for providing a secure oil supply. Empire order and Trans-Atlantic cleavages are bound to create a non-integrated gap in the value chain of oil supply in the Gulf region. Transformation of the non-integrated gap requires a strong connection with a functioning core. A preventive strategy, not a preemptive strike, is suitable for energy supply security. The fight against radicalism and terrorism is also important for the security of oil supply. UN organs and mechanisms alone are not adequate to address all the problems in the Gulf region related to oil supply security. An internally working power balance should be constructed as a preventive strategy among Arabs, Iranians and Israelis, with the support of existing and newly integrated mechanisms originating from NATO, the EU, the US and the Asia-Pacific region.

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ENERGY SECURITY AND THE ENVIRONMENT IN EASTERN EUROPE: THE CASE STUDY OF UKRAINE

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Abstract: For Belarus, Moldova and Ukraine, energy security has become a top priority because of their acute vulnerabilities. These states consume far more energy relative to the size of their economies than Western European countries because of the relatively large size of the industrial sector in their economies and energy inefficiencies in all sectors. Large quantities of natural gas and oil are imported from or through the Russian Federation to fuel this demand and to compensate for insufficient domestic energy supplies. These countries lack a diversity of energy suppliers and have been subject to gas supply interruptions and sharp price increases, allegedly to advance Russia's economic and political interests.

In response to these risks, Belarus, Moldova and Ukraine are attempting to enhance their energy security with a variety of policies and programs. It is critical for these countries to devise energy policies from a comprehensive perspective, including the likely environmental impacts of any proposed energy policy. With a broad policy perspective, governments can determine the best way to achieve their energy security goals without undermining other policy objectives. It is especially important that governments be cognizant that the negative environmental impacts of their energy policies may *themselves* create security challenges.

Ukraine has recently responded to its energy insecurities with new policies, most notably its "Energy Strategy Until 2030". Drafted and adopted in 2006 in the wake of gas supply interruptions and steep price hikes, the Strategy focuses on how Ukraine can meet a growing energy demand while reducing gas imports. The Strategy calls for a dramatic expansion of nuclear and coal power, but neglects to answer how these strategies are better than the alternatives. The environmental and social consequences of the Strategy have yet

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to be adequately analysed and the Strategy raises difficult questions for both Ukraine and its neighbours.

1. Introduction

Though long an area of concern, energy security became a top priority in Ukraine following the steep price increases and supply interruptions of natural gas imports in 2006. Ukraine imports the vast majority of the natural gas it consumes from the Russian Federation's state-owned Gazprom. Since the break-up of the Soviet Union, Ukraine had continued to enjoy deeply subsidized gas prices from Russia and it was only in 2005 that Gazprom proposed Ukraine pay the market price of \$230 per 1,000 m^3 (Heinrich, 2006) – more than quadruple the \$50 per 1,000 m^3 Ukraine's state-owned Naftogaz had been paying. Naftogaz reportedly signed a contract with Turkmenistan on December 29, 2005, that would have provided Naftogaz with up to 41 billion cubic meters (bcm) at \$50 per 1,000 m^3, but apparently Turkmenistan signed a contract with Gazprom for the same gas shortly after signing the contract with Naftogaz (IEA, 2006).

Unable to reach a deal with Gazprom, Ukraine saw its gas supply cut off on January 1, 2006, and the supply was not restored until January 4, when Naftogaz and Gazprom signed a deal with a third party, RosUkrEnergo, a Swiss-registered company (Dubien, 2007). The "January 2006 Gas Agreement" stipulated that RosUkrEnergo would handle all gas imports into Ukraine and sell the gas to Naftogaz at \$95 per 1,000 m^3 at the border (IEA, 2006). This was a temporary agreement that was followed by an October 2006 contract signed in Moscow to provide Ukraine with 55 bcm of gas in 2007 at \$130 per 1,000 m^3. This gas was supposed to be delivered from central Asia to Ukraine through Russia was therefore not actually Russian gas: 42.5 bcm from Turkmenistan, 8.5 bcm from Kazakhstan, and 7 bcm from Uzbekistan (Tsarenko, 2007).

Natural gas is by far Ukraine's most important energy source, providing 47% of Ukraine's Total Primary Energy Supply in 2004 with 75–80% of this gas supplied either by Russia or through Russia from Turkmenistan (IEA, 2006). Ukraine's industrial and residential sectors are both heavily dependent on gas for heating and these steep increases in the price of gas threaten the competitiveness of the Ukrainian economy, the well being of Ukraine's population, and the stability of the Ukrainian government. It was widely speculated that the pressure from Gazprom was inspired by the Kremlin's desire to punish the West-oriented government that came to power in the so-called "Orange Revolution" (Dempsey, 2006).

The Constitution of Ukraine provides for the right of citizens to a safe and healthy environment and Ukraine's Energy Strategy Until 2030 explicitly states that the energy needs of the country will be met "*in a safe and environmentally friendly way*", but if the Strategy is followed, the predictable result will be serious adverse consequences for the environment due to its dubious focus increasing domestic energy production and consumption to replace gas imports. As the International Energy Agency has already noted, the Strategy "*seems unrealistically challenging and possibly not economic*" so the plan may never in fact be implemented (IEA, 2006). Still, it is worthwhile to consider the environmental consequences of the Strategy if it was carried out according to plan.

2. Summary: Ukraine's Energy Strategy

First and foremost, Ukraine's "Energy Strategy Until 2030" is a plan to meet an expected growth in primary energy demands while simultaneously reducing natural gas imports. Given Ukraine's present dependence on gas imports, the Strategy calls for an aggressive expansion of domestic energy supplies, particularly from new nuclear power plants and from coal. In the baseline scenario, the Strategy calls for the construction of 22 new nuclear reactors in order to expand nuclear power production from 88.8 billion to 219.0 billion kilowatt-hours (kWh) by the year 2030 (Energy Strategy Until 2030, 2006). In the same baseline scenario, the Strategy calls for coal consumption to increase from 43.5 million to 101.0 million tons in the same time span. In contrast, the Strategy does not foresee a significant role for renewable energy in Ukraine's energy mix, with renewable sources of energy ultimately producing less than 1% of the quantity of power produced by nuclear reactors in 2030.

The Strategy is also notable in its almost exclusive focus on energy supply with little attention to reducing energy demand. Given Ukraine's dubious status as having one of the world's most energy-intensive economies (IEA, 2006), the Strategy is surprisingly quiet about the potential to enhance Ukraine's energy security, make its economy more competitive, and minimize impacts on the natural environment and human health by reducing energy demand through improved energy efficiency. Energy efficiency is likely the most cost-effective strategy for balancing energy demands with energy supplies and has the potential to make Ukraine more competitive in international markets by reducing energy expenses. Finally, there is no energy supply as environmentally friendly as a reduced demand for energy.

The literal and figurative bottom line of the Strategy is that Ukraine's "Energy Dependence Ratio" will decline from 54.5% to 11.7% between 2005 and 2030 (Energy Strategy Until 2030, 2006). The Strategy is largely about replacing imported gas heating with domestically produced electric heating. This inherently inefficient and difficult plan reveals the Ukrainian government's overwhelming desire to enhance its energy security.

3. Promoting Energy Security

Energy security has been defined by the United Nations Economic Commission for Europe as "*the availability of usable energy supplies, at the point of final consumption, at economic price levels and in sufficient quantities and timeliness so that, given due regard to encouraging energy efficiency, the economic and social development of a country is not materially constrained*". With this definition, it is undeniable that Ukraine presently faces substantial risks to its energy security and the stated intention of its government to enhance the country's energy security is understandable.

Ukraine's specific energy security risks include:

- Insufficient domestic energy supplies to meet domestic energy demand
- High energy intensity of the economy due to its large industrial component and the inefficient use of energy resources
- Reliance on Russia to supply natural gas, nuclear fuel, and oil
- Rising price of imported Russian natural gas
- High price of imported oil
- Technological and economic barriers to substituting electricity for gas in heating
- Substantial energy losses in transit

Given these threats to Ukraine's energy security, the mitigation of these risks can broadly be characterized with the following solutions:

- Minimizing energy demand by improving energy efficiency and conservation
- Increasing production of domestic energy supplies
- Diversifying energy supplies
- Increasing flexibility of energy systems
- Holding strategic reserves of critical energy sources

Risks to energy security can never be entirely eliminated, but they can be mitigated. Ukraine's particular vulnerabilities should be addressed with specific cost-effective policies tailored to its particular situation that should not ignore the country's related policy objectives including the protection of the public health and the health of Ukraine's natural environment.

4. Broadening the Policy Perspective

Ukraine's Energy Strategy Until 2030 is a product of Ukraine's energy insecurity. Consequently, the enhancement of the country's energy security is understandably at the top of its energy policy agenda. Given that energy policy has such wide and deep impacts in other policy areas, it would be wise to consider these other policy areas while evaluating alternative energy strategies.

In addition to affecting Ukraine's energy security, Ukraine's economy, public health and safety, and natural environment will be heavily impacted by the country's energy policies. Focusing on the environmental impacts, Ukrainian policymakers would need to answer a variety of important questions, including:

Could the Strategy's objectives be achieved by less environmentally damaging means? Is the potential for cost-effective energy efficiency improvements being fully realized? Are energy resources being used rationally? What are the external, non-monetized costs of different energy sources? Factoring in the external/environmental costs of their energy consumption, are there industrial facilities that would best be closed? Do the environmental impacts of the energy Strategy themselves create security challenges?

It would be prudent for Ukraine's policymakers to anticipate the environmental impacts of the Strategy assuming its successful implementation and to weigh these impacts during the development of the Strategy. Energy security does not exist in a policy vacuum, it is therefore critical to design energy policy from a broader policy perspective to insure that one policy objective is not sacrificed to accomplish another and where possible, multiple objectives can be achieved simultaneously.

5. Environmental Impacts of Increased Coal Production

The Energy Strategy Until 2030 plans for a substantial expansion of coal production and consumption in Ukraine to help meet the anticipated growth in energy demands while decreasing natural gas imports. This energy pathway will be difficult to follow given the decline in the productivity in Ukraine's coalmines since the 1970s and the fact that the Ukrainian coal mining industry is largely unprofitable with production costs higher than the price of Ukraine's low-quality coal (IEA, 2006). The industry is kept afloat with sizable government subsidies. Assuming that these and other serious problems are resolved and the production targets set in the Energy Strategy can be met, it is important to consider the likely environmental impact of the proposed increase in domestic coal production.

Ukraine's coal is located in six regions: Donetsk, Luhansk, Dnipropetrovsk, Lviv, Kirovohrad and Volyn, with more than 95% of the reserves in the first three (IEA, 2006). In 2005, Ukraine produced 78.0 million tons of coal from these regions and according to the Energy Strategy, will increase that production to 121.5 million tons under the "worst case" scenario and 146.3 million tons under the "best case" (Energy Strategy Until 2030, 2006). Either case represents a significant increase in coal production from new mines and rehabilitated old mines with significant environmental impacts.

The Strategy recognizes that the environment is contaminated from coal mining, but offers very little input on how to mitigate these negative consequences. According to the Strategy, 750 million to 2.7 billion cubic meters of methane are emitted into the atmosphere from existing coalmines in Ukraine. As a powerful greenhouse gas 21 times more potent than carbon dioxide (IPCC, 2000), these emissions are of global concern. These coal bed methane emissions also have real value that is being lost. Capturing these methane emissions would have value both as a quality fuel that can replace natural gas imports and value on international carbon markets as emissions reduction projects. Private investors have been particularly interested in developing coal mine methane projects through the Kyoto Protocol's "Joint Implementation" mechanism (Methane to Markets Partnership, 2006).

The mines create serious water quality problems as well. At present operating levels, the mines pump out an estimated 600 million cubic meters of water per year. Because the water is not now adequately purified, more than 1 million tons of mineral salt are discharged into local rivers every year (IEA, 2006). These discharges can negatively affect native plant and animal species as well as negatively impact agriculture downstream. As Ukraine increases its coal production, these water problems will only get worse unless the production process is significantly cleaned up.

Once a mine is exhausted, there remains the threat that mine wastewater will contaminate local rivers. There is also a threat that the heavy metals and toxins in the tailings will contaminate the water supply if not properly handled. Additionally, like old mines, the new coalmines planned in the Strategy will lower the water table locally as water is pumped out of the underground mine. A lower water table can have serious impacts on the vegetation on the surface including local agriculture.

More visibly, the waste piles (tailings) from coal mining operations are usually left untreated on the landscape surface in Ukraine. These tailings can burn if not properly covered with earth as they are in OECD countries. Additionally, an increase in mining has the potential to cause more incidents of local earth subsidence and flooding. Mining already occupies 22,500 ha in Ukraine (IEA, 2006) and the opening of new mines and expansion of old ones can aggravate these problems if production practices are not improved.

The Strategy details the expected costs and needed investments for meeting its coal production targets, but does not call for funding efforts to reduce the negative environmental impacts of the planned increase in coal production.

6. Environmental Impacts of Increased Coal Consumption

The combustion of Ukraine's coal also causes serious environmental problems and these problems are likely to be exacerbated by the increase in coal consumption stipulated in the Energy Strategy. The Strategy calls for the continued use of domestically produced coal to meet Ukraine's needs. Though understandable from an energy security perspective, Ukraine's low-quality, high-sulphur and high-ash coal generates substantial emissions when combusted (IEA, 2006). The Energy Strategy declares that it is an objective to "*decrease the existing negative impacts on the environment through localization (trapping) emissions and discharges with their following neutralization, storage and disposal*", but goes on to say that there are "*next to no means to attract necessary investments that could help solve environmental problems in this economic sector in the short run (up to 10 years)*."

The plan to substitute coal for natural gas in meeting Ukraine's energy demands will have unfortunate consequences for the atmosphere. When combusted, coal emits roughly double the carbon dioxide emitted by natural gas for the same amount of energy. The IEA estimates that the carbon dioxide emissions from coal combustion are now over 100 million tons annually from a current consumption of 59.6 million tons of coal. With a planned increase in coal combustion to 114.9 million tons in the "worst case" scenario and 153.5 million tons in the "best case" scenario, carbon dioxide emissions from coal consumption will increase proportionately. The IEA estimates that the increase in coal consumption will result in an increase of carbon dioxide emissions of between 213 and 230 million tons annually. Even if funds for abatement were available, there is no existing technology for capturing and storing carbon dioxide emissions from coal combustion.

Carbon dioxide is by no means the only notable emission from coal combustion. Sulphur dioxide is emitted when coal is burned and produces acid rain when it oxidizes in the atmosphere leading to acidification of rivers and the degradation of soils and forests (U.S. EPA, 2007). High altitude forests are especially vulnerable. Insect and fish species can be killed. Agriculture can be adversely affected as soil quality suffers and the application of additional fertilizers is necessary to replace lost nutrients. Additionally, the weathering of buildings is accelerated from exposure to acid rain (U.S. EPA, 2007).

Because the sulphur dioxide can be carried downwind across international borders, the combustion of coal in Ukraine is a regional environmental issue.

The high sulphur content of Ukrainian coal makes acid rain an especially important environmental issue raised by the Energy Strategy. Ukrainian power plants and steel mills have no pollution control equipment despite the availability of flue gas desulphurisation technology that can remove sulphur-containing gases from the stack of coal-fired power plants (IEA, 2006). Ukraine is party to the *1979 Convention on Long-Range Transboundary Air Pollution* and has signed, but not ratified the *Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on Further Reduction of Sulphur Emissions* (IEA, 2006).

Nitrogen oxides (NOx) are emitted from coal combustion with serious environmental and health consequences. Nitrogen oxides are highly reactive gases that: can form ground-level ozone (smog), which can trigger serious respiratory problems; react to form nitrate particles, acid aerosols, as well as NO_2, which also cause respiratory problems; contribute to formation of acid rain; contribute to nutrient overload that deteriorates water quality; react to form toxic chemicals; and contribute to global warming (U.S. EPA, 1998). Like sulphur dioxide, NOx can be carried downwind across international borders and is a regional environmental issue.

Particulate matter, microscopic particles suspended in gas, emitted during the combustion of coal can also cause significant damage to human health. Inhaling particulate matter has been shown to cause asthma, lung cancer, cardiovascular problems, and can lead to premature death (U.S. EPA, 2004). Because of these serious health consequences, the European Commission has adopted limits for particulate matter in the air. Ukraine's low-quality coal has a very high ash content – 37.9% for coal used domestically (IEA, 2006) – making the emissions of particulate matter an even more serious matter.

7. Environmental Impacts of Increased Nuclear Power

Nuclear power is central to Ukraine's strategy to enhance its energy security by reducing natural gas imports. This strategy has serious drawbacks though for a number of reasons. Nuclear power has been a sensitive subject in Ukraine since the Chernobyl disaster in 1986. Still, nuclear power has been an important supplier of electricity in Ukraine providing 88.8 billion kilowatt-hours (kWh) in 2005 from four nuclear power plants with a combined 15 reactors (Energy Strategy Until 2030). Nuclear power constituted 16.2% of the Total Primary Energy Supply in Ukraine and 48% of the electricity produced in 2004 (IEA, 2006). Controversially, Ukraine's Energy Strategy calls for a tremendous expansion of nuclear power production with the construction of 22 new nuclear reactors and the extension of the service life of 13 existing plants to produce in total 186.2 billion kWh by 2030 in the "worst case" scenario and as much as 238.3 billion kWh in the "best case" scenario (Energy Strategy Until 2030).

Ukraine's Energy Strategy explicitly calls for expanding electricity production from nuclear plants and coal-fired thermal plants to replace natural gas use in heating in all sectors of the economy. The inherent inefficiency of this strategy is striking. Most of the energy produced at Ukrainian power plants is lost as waste heat in the conversion to electricity and 14.7% of whatever electricity is produced is lost in transmission (Energy Strategy Until 2030). The present energy system of burning natural gas to produce heat on-site results in far fewer energy losses. Furthermore, most of Ukraine's electrical supply network cannot operate at the higher currents that would be necessary for the widespread use of electric heating (MAMA-86, 2006).

In addition to the enormous capital costs of constructing and operating new nuclear reactors, the Ukrainian government must consider the additional expenses of replacing the power supply infrastructure and replacing gas heating systems with electric heating systems. It is worth studying whether investing in energy-efficiency measures could reduce natural gas imports more cost-effectively. Given that the Energy Strategy requires infrastructure investments at the household level, it is worth considering whether it is more worthwhile to better insulate homes than to replace their gas heaters with electric heaters and build new nuclear power plants to power the new electric heaters.

Assuming that the Energy Strategy is carried out according to plan, the environmental risks associated with the increase in nuclear power production are substantial. The first issue is that of operational accidents contaminating the environment and harming human health. The Chernobyl reactor meltdown contaminated much of Europe with radioactive fallout and rendered large areas of Ukraine and Belarus uninhabitable (Cherp, 2007). A repeat incident of this scale must be avoided at all costs. Nuclear accidents of a smaller scale are more likely to occur and the consequences of unintended releases of radioactive material on a small scale are still very serious – endangering human health and contaminating the environment. Before such an ambitious nuclear power policy is pursued, the government must be able to adequately answer questions about the siting of any nuclear facilities, the safety of the technology, and the safety of the plant's operation.

Even with perfect operations and with no accidents at all, there remains the very difficult questions of what to do with the Spent Nuclear Fuel (SNF), radioactive waste generated during operation and decommissioned nuclear power plants. As the Energy Strategy succinctly puts it: "*No progress has been made in Ukraine so far to develop and implement a national Radioactive Waste Management Strategy*". Presently, radioactive waste generated at the plants is being "temporarily" stored on-site with no long-term solution to the problem (IEA, 2006). Contamination of the land and ground water from the wastes is a serious risk.

Disturbingly, Ukraine's Energy Strategy anticipates storing SNF for as much as 50 years while a long-term solution is devised. In addition to an environmental risk, this plan constitutes a very real international security threat created as an unintentional consequence of Ukraine's desire to improve its energy security. SNF contains Plutonium-239 and Uranium-235 (End Points for Spent Nuclear Fuel, 2003). Both of these isotopes are suitable for nuclear weapons. Although SNF does not contain either of these isotopes in concentrations high enough to be suitable for nuclear weapons, the fuel can be reprocessed to achieve these concentrations as the Democratic People's Republic of Korea (North Korea) did recently (Sanger, 2003). Alternatively, the SNF could be exploded with conventional explosives as a so-called "dirty bomb" (End Points for Spent Nuclear Fuel, 2003).

The proliferation threat is not that Ukraine aspires to rebuild a nuclear weapons arsenal after having voluntarily given up their nuclear weapons after achieving independence. The threat is that SNF or other radioactive material could be stolen and sold on a nuclear black market. According to Transparency International's "Corruption Perceptions Index 2007" Ukraine ranked 118th in the world with a CPI score equal to that of Malawi and Mali. Corruption and SNF are a potentially dangerous combination.

8. Greenhouse Gas Emissions, Kyoto and Ukraine

As a signatory to both the United Nations Framework Convention on Climate Change and the Kyoto Protocol as an Annex I party, Ukraine is presently in an excellent position to take advantage of Kyoto's "Flexible Mechanisms" including both "Emissions Trading" and "Joint Implementation". Ukraine's Energy Strategy as currently constituted will eliminate that potential because the Strategy would greatly increase Ukraine's greenhouse gas emissions.

Presently, Ukraine is substantially below its target GHG emissions reductions under the Kyoto Protocol. This is because 1990 was set as the baseline year for the national emissions reductions under Kyoto and Ukraine experienced a severe economic slowdown in the 1990s with commensurate reductions in GHG emissions (Gorina, 2006). That surplus of allowable emissions, known as Assigned Amount Units (AAUs), is a real financial asset that Ukraine risks losing by pursuing a carbon intensive energy strategy.

In the flexible mechanism known as "emissions trading", Ukraine's surplus AAUs can be sold directly to countries that are above their emissions target for the 2008–2012 commitment period, or perhaps to other interested parties. These AAUs could be worth billions of U.S. Dollars, and are lost as Ukraine increases its emissions (World Bank, 2006). Potential buyers have expressed keen interest that if they were to purchase AAUs from Ukraine, the revenue would be used to fund GHG emissions reduction projects or some other way to benefit the natural environmental in a so-called “Green Investment Scheme” (GIS) (Gorina, 2006).

Ukraine would be wise not to neglect this potential revenue source. The government could create a GIS through which the revenue from forward sales of their AAUs could be invested in energy efficiency projects that presently lack an adequate funding source, perhaps by using the funds as a large endowment for an energy efficiency revolving fund. Funding would then be available to modernize industrial facilities or make energy efficiency improvements in multi-story residential buildings, for instance. Investing in energy efficiency through a GIS would enable Ukraine to sell even more AAUs because energy efficiency projects would further reduce Ukraine’s GHG emissions and thus expand its surplus of AAUs. Importantly, investments in energy efficiency would have the important additional benefits of enhancing Ukraine’s energy security and improving its economy.

The other Kyoto “flexible mechanism” available to Ukraine is known as Joint Implementation (JI). In the Kyoto Protocol, Annex I parties that cannot independently meet their reduction commitments can also purchase emissions reduction credits generated from projects in other Annex I countries with AAU surpluses, such as Ukraine. Through JI projects, AAUs are converted to Emissions Reduction Units (ERUs). Significantly, the European Union Emissions Trading Scheme (EU ETS) permits the trading of ERUs. Credits in the EU ETS 2nd Commitment Period are currently trading at roughly €20/t. Compared to Kyoto’s third flexible mechanism “Clean Development Mechanism”, JI is much less mature. Consequently, to maximize foreign investment in Ukraine through JI, the Ukrainian government should build the necessary institutional capacity and identify and prepare a pipeline of JI projects to market to potential investors. Again, projects that enhance the energy efficiency of the industrial or energy sectors would enhance the energy security and economic development of the country.

9. Conclusions

Ukraine’s Energy Strategy Until 2030 declares that meeting the country’s energy needs in an environmentally friendly way is a priority, but the plan itself would likely have significant adverse impacts on environment if actually implemented. Ukraine has acute energy security vulnerabilities and its desire to reduce these vulnerabilities is utterly justifiable. However, the plan to replace natural gas imports by massively expanding coal and nuclear power production and consumption will predictably do damage to the environment in a variety of ways and is an inherently inefficient strategy. Given that energy efficiency has already been identified as the most cost-effective means to reduce gas imports and would have the co-benefits of improving Ukraine's balance of trade, increasing its economic competitiveness, promoting social welfare *and* improving the quality of Ukraine's air, land, and water, one is forced to wonder why the Energy Strategy does not more aggressively pursue it. International Emissions Trading under the Kyoto Protocol could provide an ideal source of revenue for funding energy efficiency projects under a "Green Investment Scheme" and should be seriously considered.

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ECOLOGICALLY FRIENDLY UTILIZATION OF COAL PROCESSING WASTE AS A SECONDARY ENERGY SOURCE

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Abstract: An influence of production technology of highly concentrated coal slurry-water suspension (CSWS) on its rheological parameters, sizing and electrokinetic parameters of the disperse phase particles has been investigated. As a result, the most effective regime of the suspensions has been determined.

The use of CSWS as a secondary fuel causes much less emission of sulfur and nitrogen dioxide and ash particles as compared to primary coal.

Keywords: Highly concentrated coal slurry-water suspension, rheological properties, sedimentation stability

1. Introduction

Available reserves of organic fuel such as natural gas, oil and coal are constantly decreasing which increases the price of fuel. Energy-carrier exporting countries tend to use energy carrier price issues as a tool to influence political issues in the energy carrier exporting countries. Ukraine is still an energy carrier importer; however, there is quite a significant amount of prospective secondary energy sources in Ukraine. There are thousands and millions of tons of coal processing wastes, which, in fact, can be classified as a depleted coal-containing mixture.

As the rich and close-to-surface coal-fields of the Donbass region are mostly used up, the coal industry gradually turns to the processing of deeper and/or lower grade deposits. This leads to higher processing prices and lower emissions of harmful chemical compounds during processing and use of the low-grade coal. This processing also produces higher amounts of liquid and solid waste materials. Coal-containing slurries tend to spontaneously combust and constantly emit harmful chemicals into the environment both as gases or ground water pollutants. This makes slurry pits quite unsafe places.

On the other hand, some slurries (especially formed after high-grade coal processing) still contain enough organic compounds and can be used as a secondary fuel. However, direct combustion of any slurries is quite problematic and inexpedient.

That is why the development of special mixtures based on the slurries can be a possible solution for the utilization of slurries. Solutions such as hydrogenation, motor fuel synthesis or the development of highly concentrated CSWS are possible ways to utilize coal processing slurries.

The first and second solutions are rather expensive and require low-ash and refined coals while the latter solution can work with low-grade coal slurries and does not require significant processing.

For example, highly concentrated CSWS can be used for direct combustion in boilers (Ouriev, 1980, 1985; Makarov et al., 1989; Ouriev et al., 2000). As reported in Bratychak et al., 2001, it is possible to achieve up to a 30% reduction of carbon oxide, sulfur dioxide and nitrogen oxide emissions at combustion of the coal suspensions as compared to combustion of the dry coal dust. Therefore, one can expect a similar reduction in harmful gas emissions at combustion of CSWS. Moreover, the burn-up ratio for CSWS is higher than the ratio for the primary coal.

2. Formation of CSWS and Possible Solutions

One has to take into account the comparatively low content of the combustible organic substance in the coal slurries which never exceeds 35–55%. Therefore, CSWS should be enriched with disperse phase particles to keep the suspension combustible. Besides that, the suspension should remain sedimentationally stable and fluid. The latter requirement is especially important because CSWS can be used in the technology of direct combustion, which does not have any dehydration stage preceding combustion. Direct combustion technology requires CSWS containing 65–70% of the coal material or higher. Then such suspensions can be piped in the laminar mode with low energy consumption (Humpel and Breshner, 1979). Determination of the optimal grain composition is very important to achieve the needed stability and fluidity of any suspension. This composition varies depending on the suspension composition, coal quality and type, and some other parameters. It has been found that bi-fractioned suspensions containing disperse phase particles of 20–40 μm (fraction 1) and of 150–200 μm (fraction 2) have the best stability and fluidity (Makarov et al., 1989; Degtyarenko et al., 1990; Gamera et al., 1990).

Modern technologies of the suspension's preparation use the so-called 'wet' grinding of coal. Water moistens coal and prevents coal particles from tight aggregation. Water also promotes better mixing of the particles and lowers energy consumption during grinding. It is well known that any coal is in fact porous material and water can be fixed inside the pores acting as a lubricating agent. Finally, the 'wet' process is safer because it prevents self-combustion of the material.

However, it has some serious technological shortcomings. As was mentioned above, CSWS should be bi-fractioned to remain sedimentationally stable. It is quite a problem to achieve the needed bi-fractional distribution after simple one-stage grinding. This problem becomes even more serious for low-ash or refined coal. This material can not be practically bi-fractionally ground using simple one stage grinding. That is why two-stage grinding technologies are more popular than one-stage schemes.

The first stage of the two-stage scheme involves a ball or rod mill and results in the formation of a low-concentrated water coal suspension (up to 40% concentration of the coal phase) sized at 20–40 μm. Concentration of the suspension increases at the second stage and is enriched with larger particles sized up to 200 μm until the coal concentration reaches the needed value.

This technology requires more energy but provides a wider opportunity to add various compounds to change the physio-chemical properties of the mixture. This technology also allows the use of low-grade coal wastes or non-clay based coal-containing minerals.

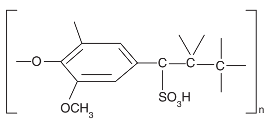
3. Experimental Results and Discussion

We investigated the various waste materials of the primary coal hydroconcentration (hydrocyclone sands). Waste material 1 (G brand coal concentration waste) looks like dark powder. Ash percentage is 42.5%, water content is 1.65%. Average particle size is 0.1–5 μm.

Waste material 2 (waste of Esinovo mine concentration plant) has a water content of 7% and an ash percentage of 23%.

Waste material 3 (T brand coal concentration waste) has a water content of 15% and an ash percentage of 43.1%.

Sodium lignosulfonate (LS)



and lignosulfonic acid salts (with some additional amount of alkali) were used as plasticizers.

Three types of the coal waste were investigated:

- Hydroconcentration wastes (hydrocyclone sands) after processing of “G”-brand coal (water content of this material was 1.65% mass and ash content was 42.5% mass) (source material **A**)
- Waste products of the Esinovo coke plant (Donetsk region, Ukraine) (water content was 7% mass and ash content was 23% mass) (source material **B**)
- Coal waste products collected after concentration of “T”-brand coal at the central Kondratyevo concentrating plant (Donetsk region, Ukraine) (water content was 15 mass% and ash content was 43.1% mass) (source material **C**)

Grinding was done in a 1.3 litre ball grinder with steel balls of 28 and 10 mm in diameter. Grinding was maintained until the percentage of particles sized over 250 μm dropped below 0.1%. It took about 30 min with the grinder at 75 rpm. Grinding for longer resulted in much higher viscosity of the system probably caused by the higher content of the nano-sized clay particles in the suspension.

A series of experiments was performed to determine the influence of LS concentration on properties of the suspension and to find an optimal concentration of this admixture. Concentration of the disperse phase in the suspensions under investigation was 61%, 63%, and 65% mass. Dependence of viscosity of the slurry-coal suspensions from the source material **A** on the concentration of LS is shown in Figure 1. Other source materials showed the same tendencies. As seen from Figure 1, the viscosity of the disperse system steadily and relatively quickly decreases with an increase of LS concentration up to 1.0–1.1% mass. It was found that external mechanical disturbance increases viscosity of the system containing lower (<1% mass) concentrations of LS. On the other hand, higher concentrations of LS (over 1% mass) does

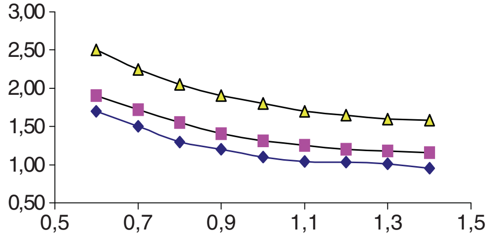


Figure 1. Dependence of viscosity of one stage grinded slurry-coal suspensions (prepared from source material **A**) on concentrations of LS for the following concentrations of disperse phases: ♦ 61% mass ■ 63% mass, and Δ 65% mass.

not result in any significant decrease in viscosity. Therefore, based on this result, we defined the optimal concentration of LS as 1% solid phase mass.

One stage grinding technology was used to obtain highly concentrated slurry-coal suspensions. Tables 1–3 show the technical characteristics of these suspensions.

TABLE 1. Characteristics of slurry-coal suspensions obtained from source material **A.**

Disperse phase content (mass%)	Effective viscosity (Pa·s)	Sedimentation stability (days)
59.4	0.9	3.5
60.5	1.03	5.0
61.2	1.11	5.0
62.1	1.23	6.5
63.2	1.29	7.5
64.4	1.31	8.0
65.3	1.80	8.0
66.3	2.50	10.0
67.5	3.05	10.0

TABLE 2. Characteristics of slurry-coal suspensions obtained from source material **B.**

Disperse phase content (mass%)	Effective viscosity (Pa·s)	Sedimentation stability (days)
59.1	0.68	1.5
60.4	0.75	2.0
61.3	1.11	2.0
62.2	1.18	2.5
63.5	1.32	2.5
64.3	1.52	3.0
65.1	1.88	3.0
66.2	2.35	4.0

TABLE 3. Characteristics of slurry-coal suspensions obtained from source material **C.**

Disperse phase content (mass%)	Effective viscosity (Pa·s)	Sedimentation stability (days)
59.2	0.78	2.5
60.1	0.93	3.0
61.3	1.05	3.0
62.6	1.4	3.5
63.3	1.61	4.5
64.3	1.81	5.0
65.1	1.97	5.0
66.4	2.20	5.0
67.2	2.50	6.0

As seen in Tables 1–3, increased disperse phase concentrations result in increased viscosity of disperse systems. The viscosity of water-coal suspensions receives an extra increase after passing the critical concentration of the solid phase (61–62% mass). Slurry-coal suspensions, depending on the characteristics of the slurry, pass such critical points at 65–66% mass.

A rise in the disperse phase concentration leads to better sedimentation stability of the disperse systems (this parameter was measured as time passed till disintegration of the system). This rise is probably caused by closer compacting of disperse particles. As seen from Tables 1–3, one can reach better sedimentation stability for suspensions of material **A**, while materials **B** and **C** provide suspensions with higher concentrations of the solid phase particles and lower sedimentation stability. This effect can be caused by coal and mineral compound characteristics. A denser source material provides a higher mass concentration of the disperse phase but lowers the sedimentation stability of the system because of faster gravitational compacting of the particles.

It has been found that the viscosity of the disperse system rises at an increased concentration of the disperse phase due to two effects: the rise of the volume percentage of solid compounds in the system and the change in the granulometric composition of the solid phase.

It is also known that two-stage grinding technology provides good results in preparation of water-coal suspensions (Ouriev, 1985; Ouriev et al., 2000). We used this technology to prepare a series of the suspensions with various concentrations of the disperse phase in order to test applicability of this technology to our slurry-coal systems. Concentration, effective viscosity and sedimentation stability of these systems are shown in Table 4.

As seen from a comparison of Tables 1 and 4, two-stage grinding technology provides rather worse characteristics of suspensions than one-stage grinding. Viscosity of the one-stage suspension is lower and sedimentation stability is higher than for the two-stage systems. This is probably caused by the higher content of the smaller particles after two-stage grinding. On the

TABLE 4. Characteristics of slurry-coal suspensions obtained from source material **A** (two-stage grinding).

Disperse phase content (mass%)	Effective viscosity (Pa·s)	Sedimentation stability (days)
61.4	1.21	3.0
62.2	1.33	3.5
63.1	1.38	5.5
64.3	1.48	6.0
65.1	2.15	7.0
66.2	2.65	7.5
67.3	3.45	8.0

other hand, this technology is more labour and power intensive and requires more equipment. Therefore, taking into account our results, we can conclude that two-stage grinding technology is not suitable for preparation of highly concentrated slurry-coal suspensions. One-stage grinding and 64–65% mass of the disperse phase are the most suitable solutions for this process.

Another investigation was aimed at finding the caloric value of the slurry-coal suspensions. It is known that slurry-coal suspensions can be used as pseudo-liquid fuel for heat power stations.

Direct experimental measures were carried out to find the caloric effect of burning various samples: source slurry, air-dry slurry, and slurry-coal suspensions containing 63% and 66% mass of the solid phase. All the samples were placed in a calorimeter and burned in an oxygen atmosphere. Then we measured heat emission. Results of this investigation are shown in Table 5.

As seen from Table 5, there is no significant reduction of heat emission when burning slurry-coal suspensions of materials **A** and **B** as compared to burning the corresponding source or air-dry slurry. Therefore, we can conclude that **A** and **B** based slurry-coal suspensions can be efficiently used as a fuel for heat power stations. This fuel would provide approximately the same or higher (taking into account higher burnup degree) heat output of boilers. These suspensions are stable enough to be safely piped from coal processing facilities to heat power stations. Moreover, such fuel would provide lower emissions of toxic waste gases.

C-based suspensions did not burn even in pure oxygen. This could be caused by a too low volatile combustible components content.

It is important to emphasize that the degree of burnout never reaches high values for coal types with high ash content. However, coal particles are very small in CSWS, which should enhance its burnout degree.

A crucible with coal or CSWS was placed in the muffle furnace at 750°C with a stainless steel neck placed on the bottom of the crucible. This crucible was kept in the furnace for 10 min to simulate the burning process in the boiler and ash weight was determined to find the burnout degree of a sample. It has been found that primary coal starts to burn faster than CSWS but its burning time is longer. CSWS starts to burn later but its burning time is

TABLE 5. Heat emission (kJ/kg) for various fuel samples.

	Fuel type			
Source material	Source slurry	Air-dry slurry	Suspension ($C_{solid\ phase}$ = 63%)	Suspension ($C_{solid\ phase}$ = 66%)
A	19,594.1	21,179.8	15,345.5	18,065.2
B	33,491.8	35,566.8	24,372.09	25,798.8
C	22,250.8	24,930.0	–	–

TABLE 6. Burnout degree for primary coal dust and CSWS.

Sample	Weight (g)	Solid compound weight (g)	Combustible compounds weight (g)	Ash weight (g)	Remaining combustible compounds weight (g)	Burnout degree (%)
Primary material **A**	20	19.7	11.3	9.7	1.3	88.5
CSWS based on material **A**	30	18	10.4	7.65	0.05	99.5
Primary material **B**	20	18.6	14.3	5.1	0.8	94.5
CSWS based on material **B**	30	18	13.9	4.15	0.05	99.7
Primary material **C**	20	17	9.7	8.9	1.6	83.5
CSWS based on material **C**	30	18	10.3	7.8	0.1	99.0

TABLE 7. Acid waste gas formation during primary coal and CSWS burning.

Fuel	Acid waste gas weight for 1 t of fuel
Primary coal	34.2
CSWS	25.2
CSWS + 1% of marble powder	16.1

Note: Combustible compounds content in CSWS was 60%.

much shorter and it burns almost without soot. Quantitative experiments proved a higher burnout degree for CSWS (see Table 6).

Therefore, we can conclude that CSWS provides a good opportunity to reach a higher utilization of combustible compounds from coal processing waste.

On the other hand, the burning of CSWS forms very fine dispersed ash particles with a significant specific surface area. Such particles can actively adsorb harmful acid gases formed during coal burning, reducing amounts of nitrogen and sulphur oxides emitted to the atmosphere. We have measured amounts of the acid waste gases formed after coal and CSWS burning (see Table 7). As seen from Table 7, CSWS waste gases consist only 45–55% of acid gases as compared to the primary coal burning waste gases. This is a very favourable result because significant amounts of the acid gases remain adsorbed on the solid ash surface.

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MODERN TECHNOLOGIES IN NEW LIGNITE POWER PLANTS IN KOSOVO AND THEIR IMPACT ON ENERGY AND ENVIRONMENTAL SECURITY

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Abstract: This paper summarizes potential modern technologies for large scale power generation based on lignite which should be used in Kosovo. A part of the study was done to review modern power plant technologies currently available and potential technical concepts for large scale power generation based on lignite, taking into account their high moisture content. Reference is also made to the importance of low rank coals/lignite in the international scene. The combination of the high moisture content and high reactivity of low rank coals/lignite necessitates their use close to the mine, unless they can be upgraded to value-added products with improved transport safety and economics. Their primary use is therefore power generation or to provide domestic and industrial fuels for local use, although a number of novel alternative fuel and non-fuel applications provide value-added potential. Due to the generally low mining cost of these coals, emphasis was previously placed on developing technologies to minimize capital expenditure rather than maximize thermal efficiency in their use. However, the current concerns over global warming have focused attention on developing utilization technologies to reduce the comparatively high CO_2 emissions from burning these coals.

Keywords: New technologies, lignite, moisture, efficiency, environment

1. Introduction

Kosovo has large lignite resources and their utilization for large scale thermal power generation has been envisaged in regional electricity generation plans. Accordingly, taking into account the need for new capacities, we have analyzed and completed a study on a new thermal power plant based on the Sibovc lignite field that is planned to be developed after exhausting the current mines of Bardhi and Mirash. The study analyzed two alternative unit capacities, namely 300 and 500 MW size. We assumed that the plant will be built in two phases, i.e. 900–1,000 MW in the first phase (3 × 300 or 2 × 500 MW), the first units running by 2012–2014. The second phase (4 × 300 MW, alternatively 2 × 600 or 2 × 500 MW) would start when the first phase has demonstrated its ability to generate power and sell it to the market. The aim of the study was to compare efficiency improvement and environmental protection as a result of using new technologies.

2. Kosovo's Lignite

The electricity sector in Kosovo is dominated by the power generation company, Korporata Energjetike e Kosovës – KEK, a vertically integrated system. The integrated electricity system is composed of two lignite mines at Bardh and Mirash, (Figure 1) the two lignite power plants Kosovo A and B with an overall effective capacity of from 645 to 710 MW (from an installed capacity of 1,478 MW), network transmission and dispatching, distribution network and supply (Figure 2). The main energy resources in Kosovo are found in two big lignite basins, named "Kosovo" and "Dukagjini," with exploitable lignite reserves of good quality (Figures 3 and 4).

The estimated quantity of lignite is between 11.55–14 billion tons. Lignite reserves have low sulphur content and relatively good lime (calcium oxide) concentration for partial sulphur absorption during burning. The proportion of waste land to lignite is very favourable, a fact that makes the mines very attractive for exploitation.

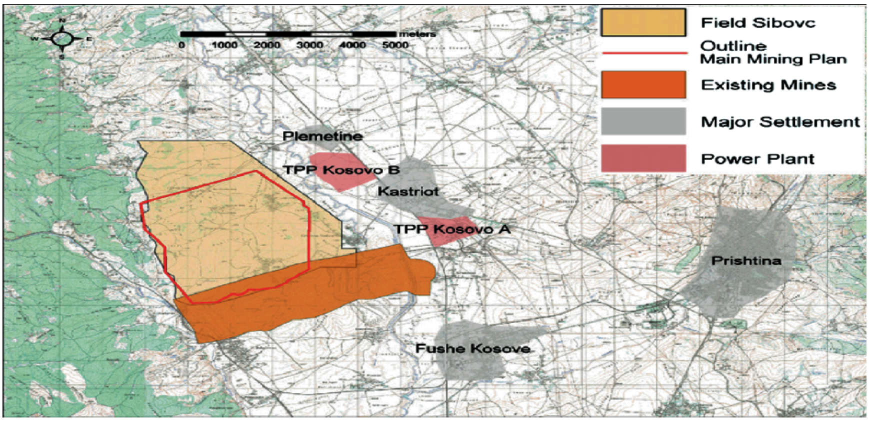

Figure 1. Kosovo's lignite basins for TPP Kosovo A and TPP Kosovo B.

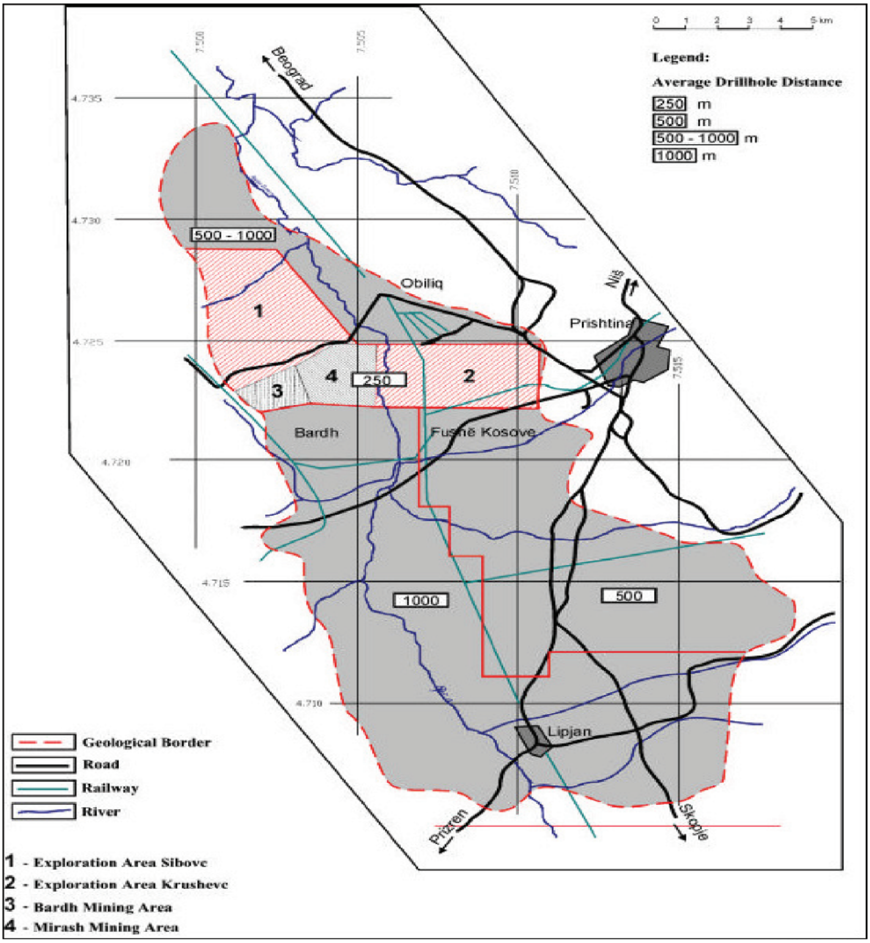

Figure 2. Cross section of Kosovo's lignite basins.

Kosovo has huge amounts of lignite resources, but for our work we have analyzed the Sibovc field where there are 840 million tons of concentrated lignite. Some 200 million tons is planned to be reserved for the supply of the existing power plants of Kosovo A and B. That mine will be a continuation of the existing Bardhi mine in the southwestern corner of the new field. It has been concluded that the cost of lignite fuel available from the new mine is among the lowest in Europe, making power generation based on Kosovo lignite very attractive. The remaining lignite resources of approximately 650 million tons would make it possible to build a 2,000 MW power plant. The mine could furnish the plant at its full load for its whole lifetime of 40 years. It has been assumed that an investor will develop these mining operations independently of the KEK mine.

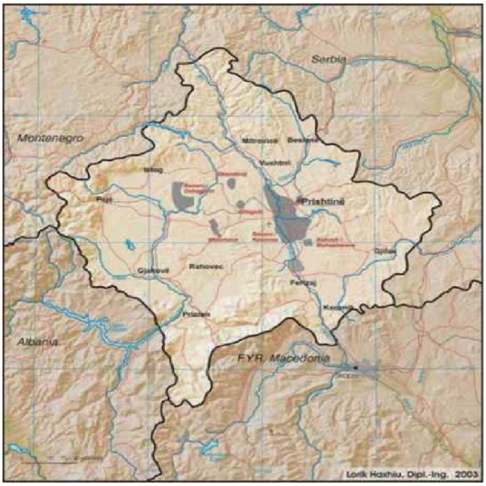

Figure 3. Kosovo's lignite basins.

Figure 4. Kosovo TSO connection.

3. Lignite Analysis

The huge lignite resources found in Kosovo can be characterized by the following analysis as determined from the Sibovc (>8,000 samples analyzed) mine (Table 1).

TABLE 1. Lignite analysis

Heat value, LHV	8,200
Ash	15.3
Moisture	42
Sulphur, total	1.1
Sulphur, combustible	0.35
Carbon	22.0
Hydrogen	2.1
Nitrogen & oxygen	13.0%
Chlorine	0.03%

TABLE 2. Typical ash analysis

SiO_2	38
Al_2O_3	6.8
Fe_2O_3	5.4
CaO	35
MgO	2.2
SO_3	8.3
Other	4.3

The typical ash analysis is assumed to be as follows based on the information on the adjoining Bardhi and Mirash fields (Table 2).

Kosovo lignite can be characterized by its relatively low ash content, low combustible sulphur as most of the sulphur is found in sulphate/sulfite form, and the existence of ample calcium in the fuel. The lignite also contains chlorine. The ash softening and melting temperatures are low and cause problems in conventional combustion processes if not properly considered at the design stage. The chlorine content of the fuel is relatively high and results in a risk of high temperature corrosion in the boiler. The real Cl-level in the fuel still needs additional research.

3.1. ENVIRONMENTAL PROTECTION PROBLEMS

Uncontrolled gas emissions from power plants consist of high level carbon dioxide, NO_x and dust. Due to the lack of maintenance of industrial waters, power plants cause water pollution as well. Temporary storage of ash presents specific problems as amounts stored can reach over 40 million tonnes which may occupy around 150 ha of potential agricultural land. Craters are also created during the exploitation of coal through open lignite mining. Ash from power plant A is transported in open stripes and stored in a way that it is not protected from dispersal into the air by wind nor from water pollution by leakage. Re-cultivation of land has not been implemented as a necessary practice. There are serious disproportions between the exploitation dynamics and revitalization of exploited areas. There is no permanent functioning monitoring system of harmful emissions in the environment. Due to the huge demand for electricity, these activities are tolerated even when legal norms and conditions for environmental protection are not met. The energy sector's current level of development creates serious environmental problems. Environmental issues need to be clearly addressed so that the future development of the energy sector is not impeded.

4. New Thermal Power Plant

4.1. POWER PLANT CONCEPT AND APPLIED TECHNOLOGY

The new thermal power plant in Kosovo will apply the latest well-proven steam power plant technology available for lignite firing. Its pollution control methods will be as called for by the current EU rules. For combustion of lignite in 300 MW units the modern Circulated Fluidized Bed (CFB) technology can be used. As the fuel contains limestone, desulphurization takes place during the actual combustion process in the boiler and very low sulphur dioxide (SO_2) emissions can be expected.

In the case of 500 MW units, more conventional pulverized firing (PF) is used and there a separate desulphurization plant is required to meet the same emission limit. Additional investigation is recommended to identify the most economical method for desulphurization. The pulverized firing concept is also calculated for the 300 MW plant for comparison purposes. Both combustion processes can meet the given nitrogen oxide (NOx) emissions (Figure 5).

The plant's flue gases will be cleaned of dust through the use of electrostatic precipitators. Thereafter, flue gases are planned to be taken into the large

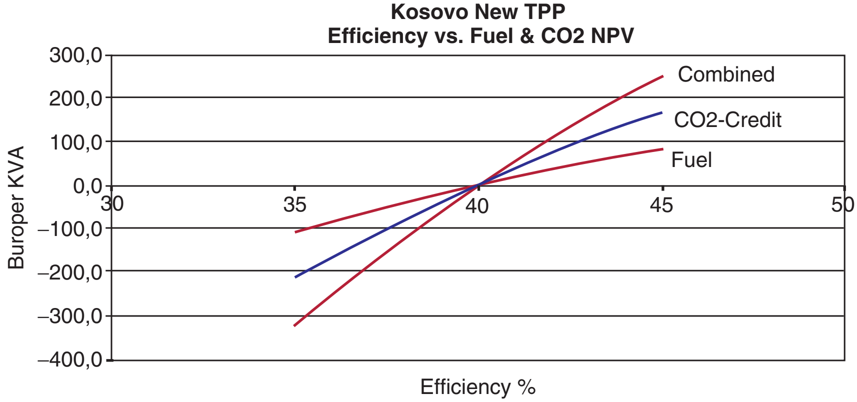

Figure 5. Kosovo's new TPP, efficiency vs fuel.

cooling tower and mixed with the exiting water vapour of the tower; i.e., the highly visible stack will be eliminated. The plant will have an overall efficiency of more than 40%. In the case of applying CFB combustion technology for the 300 MW plant, its efficiency will be 1–1.5 percentage points less, as sub-critical steam parameters would be used. The exact efficiency figures will depend on the final plant design taking also into consideration the possible implications of the Kyoto protocol for Kosovo. The plant will fulfill all requirements for environmental protection according to EU directives.

5. Applicable Technologies for New Power Plants in Kosovo

5.1. PULVERIZED COAL COMBUSTION (PCC)

The conventional coal-fired generation system used today is pulverized coal combustion (PCC). PCC can be used to fire a wide variety of coals. In PCC power stations, coal is first pulverized, then blown into a furnace where it is combusted at high temperature. The resulting heat is used to generate steam, which drives a steam turbine and generator. For many years the trend has been for efficiencies to steadily increase and hence for the rate of emissions to decrease. Efficiency improvements have been achieved through increasing the operating temperature and pressure of existing steam cycles, leading to supercritical and, more recently, ultra-supercritical PCC plant designs. This has been facilitated through the development of materials that can safely handle the higher temperatures and pressures over the life of the plant.

Supercritical plants operate at higher steam temperatures and pressures than conventional sub-critical PCC plants and offer higher efficiencies – up to 45% – and lower emissions. Ultra-supercritical technologies are emergent and relate to higher operating temperatures and pressures than supercritical plants. Research is underway to develop new materials that can safely operate at higher temperatures and pressures. Future efficiencies from ultra-supercritical plants may approach 50% with appropriate materials development.

Pressurized pulverized combustion of coal (PPCC) is also currently under development, mainly in Germany. It is similar to conventional pulverized coal combustion in that it is based on the combustion of a finely ground cloud of coal particles. The heat released from combustion generates high pressure, high temperature steam, which is used in steam turbine-generators to produce electricity. The pressurized fuel gases exit the boiler and are expanded through a gas turbine to generate further electricity and to drive the gas turbine's compressor; hence, this is a form of combined cycle power generation.

Traditionally, pulverized firing has been used for large scale boilers. Pulverized firing means processing the fuel into fine powder that has a mean particle size of 2–3 μm and a maximum size that does not exceed 30 μm. Powder is injected into the furnace with preheated air and ignition takes place due to the radiation of the surrounding flame. The actual combustion lasts only for a few parts of a second. The hottest parts of the furnace are relatively close to the theoretical combustion of the used fuel (i.e. with this lignite 1,300–1,400°C can be expected). The heat flux to the furnace walls is intense in this burner zone and is one of the main design criteria for furnace sizing. This high temperature also means that ash particles may melt and become sticky.

The lignite fuel is delivered to the boiler silos pre-crushed (i.e., the maximum size of the fuel is typically 30–40 mm). Beater wheel pulverizers are most commonly used for the pulverizing of wet lignite. There, hot flue gases from the upper furnace are sucked for drying the wet fuel. The fuel is fed into the hot inlet duct and the drying fuel flue gas mixture passes through the radial fan type pulverizer where the actual pulverizing takes place by gravitational force as the fuel clumps collide against the fan enclosure wall made of abrasion-resistant materials.

The upper part of the pulverizer has a classifier that allows only fine particles to pass and the coarse fraction is recycled back to the pulverizing process. The maximum capacity of a single pulverizer is approximately 150 t/h (i.e., a 500 MW unit needs four to six pulverizers depending on the fuel design basis (8,200 or 6,000 kJ/kg)). In order to have continuous operating capability there has to be one spare pulverizer as pulverizers need periodic maintenance at 1,000–4,000 h intervals. Ball mill type pulverizers would produce more uniform fuel powder for combustion but they are used less often with soft, wet lignites.

The high hot flue gas flow is one of the limiting factors in this respect. For large boilers a tangential firing method is commonly applied, and each pulverizer feeds its own four burners (i.e., one level at each corner). The burners fed by different pulverizers are stacked either in or close to the furnace corners to produce a swirl in the centre of the furnace. The burners are of the so-called "low NO_x" type where the combustion air is staged to reduce the absolute maximum temperatures in combustion, thus effectively reducing the formation of thermal NO_x. The burners may be either of a fixed or tilting type. Tilting burners may be used to control, for example, the reheated steam temperature by raising or lowering the flame in the furnace. From the point of view of performance, this is a method without any loss to control temperature. Another burner arrangement is to locate them on the front and rear walls. In that case the burners are fixed, and one pulverizer feeds one level. The air pre-heaters are normally of a rotary type, and due to the size of the flue gas stream there are two parallel units, each designed for 50% or 60% flow.

The steam boiler itself is either built as a tower or as a two-pass unit. The furnace and the boiler walls in the hot sections are of membrane construction, welded gastight. The tower format saves space as the superheating, reheater and economizer heating surfaces are stacked above the furnace.

The upper part of the boiler is split into two sections by a wall that also acts as a heating surface. The flue gases leave high above the economizer and there has to be a duct to bring those flue gases down to the air preheaters.

That duct is also an ideal location for placing a Selective Catalytic Reactor, SCR, for removal of nitrogen oxides. The flue gas temperature is in the range of 400–350°C, ideal for the operation of a SCR. A two-pass configuration will need slightly more space in longitudinal direction than the tower boiler but the benefit is that the connecting pipelines are slightly shorter. Pulverized fired boilers are the largest conventional steam boiler units built today. Their maximum capacity is around 1,000 MW_e and steam parameters can go up to 300 bar/600–620°C.

The ash in fuel exits the furnace mostly in the form of fly ash but a small fraction of the ash sticks onto the furnace walls and first heating surfaces. That slag is either removed by sootblowing or by just peeling off from its own weight. The slag is typically removed from the conical bottom through a wet slag drag chain conveyor. The slag is cooled, crushed and transported by trucks. During recent years the following large brown coal/lignite fired plants have been built in Europe:

Plant Capacity, MW_e Year

Neurath, 2 × 1,100 MW

Niederaussem, 1,000 MW

Boxberg, 900 MW 2000

Lippendorf, 2 × 933 MW 1999

Schwartze Pumpe, 2 × 800 MW 1997/1998

Schkopau, 495 MW 1996

5.2. FLUIDIZED BED COMBUSTION

Air is forced through a bed of ash, pulverized coal and limestone, causing rapid mixing and encouraging complete combustion of the fuel. The limestone provides a sorbet for sulphur dioxide. The heat is used in a conventional steam cycle to (Figure 6) drive a steam turbine for electricity generation. The higher heat exchanger efficiencies and better mixing allow fluidized bed combustion (FBC) systems to operate at lower temperatures than conventional (pulverized) coal-burning systems. By increasing pressures within a bed, a high-pressure gas stream can also be used to drive a gas turbine, generating additional electricity. As with conventional PCC based systems with post-combustion treatment, FBC systems can meet stringent NOx and SO_2 emission regulations. These technologies are also more suited for applications using low quality or mixed fuels, such as biomass and coal (Figure 7).

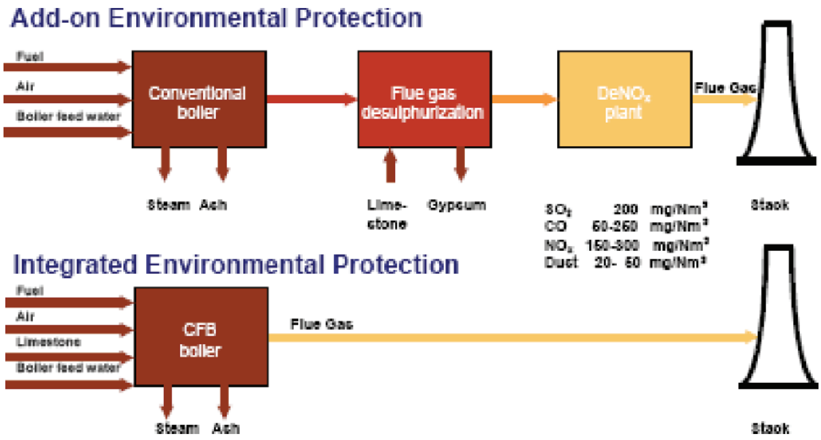

Figure 6. Fluidized Bed Combustion scheme.

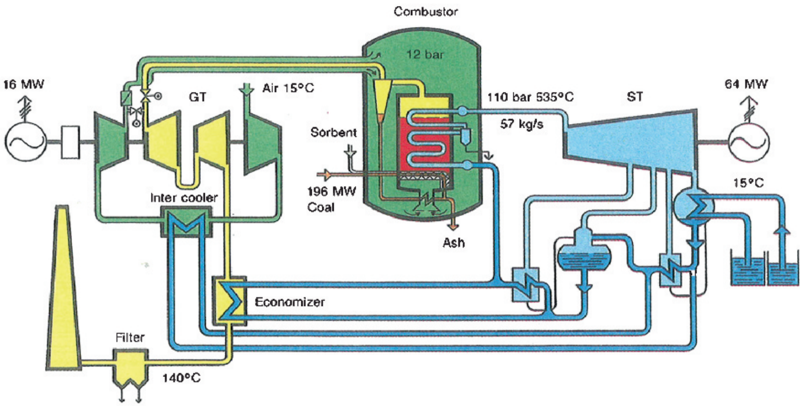

Figure 7. CFB technology scheme.

Fluidized bed combustion technologies include atmospheric pressure fluidized bed combustion in both bubbling (BFBC) and circulating (CFBC) beds, and pressurized fluidized bed combustion (PFBC). Atmospheric pressure systems are currently available commercially although they are not as widespread as conventional PCC systems. Pressurized bed systems are currently at the demonstration stage only (Figures 8 and 9).

Fluidized bed combustion was initially developed for metallurgical purposes for roasting plants (i.e., the combustible part of the feed material was removed) and not to destroy or melt the base material which came out as ash. The combustion took place around 900˚C.

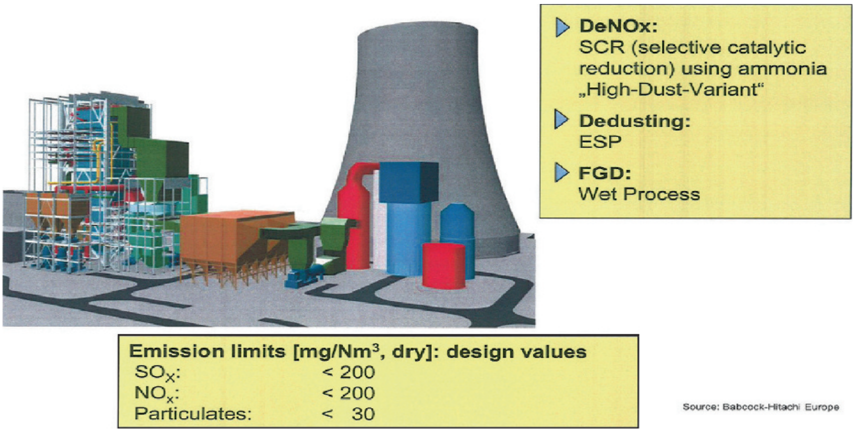

Figure 8. PFBC technology scheme.

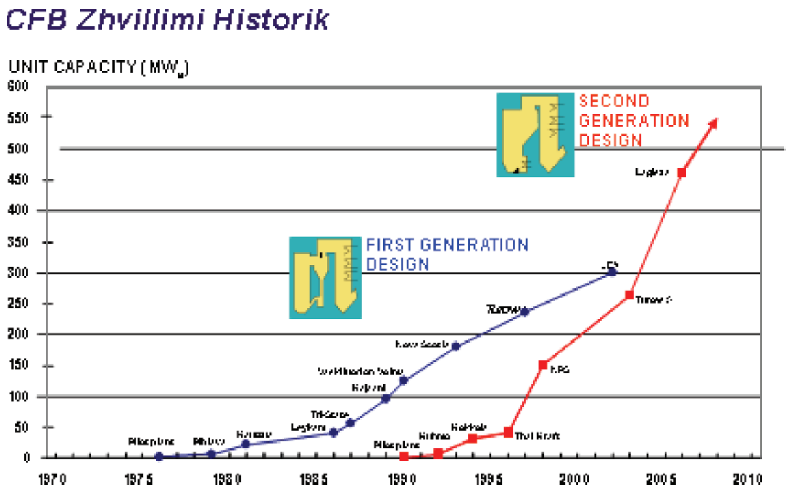

Figure 9. Historical development of CFB.

The partial introduction of combustion air underneath the bed made it bubble and that gave the name Fluidized Bubbling Bed, FBB. Gradually this bubbling bed technology was introduced for steam generation from high moisture content fuels as the bubbling bed offered an ideal place for particles requiring a long combustion time and the bubbling hot ash made the ignition of wet fuel simple. In the 1970s and early 1980s the concept attracted more and more interest from boiler makers but a major obstacle was that full scale coal combustion was not possible as FBB required too high of a combustion temperature and the ash in the bed melted and then solidified.

It was recognized that by increasing the fluidizing air volume under the fluidizing grate, the bed started to fly. Circulating Fluidized Bed, CFB, was born. In that design the upward velocity in the furnace area is 4–6 m and the material flows with the flue gases up to a separator cyclone. There the heavy particles are separated and they are recycled back to the bed through a loop seal/ash cooler. The clean flue gases leave the separator for the further heating surfaces. This concept made it possible to introduce necessary combustion air in stages at different levels of the furnace and maintain the combustion temperature at the prescribed 900–950°C level even with dry coals. It also made possible the utilization of high ash fuels as the bubbling bed tends to be choked by the high ash content.

It was also recognized that the combustion temperature of 850–950°C is quite ideal for the calcination of limestone to calcium oxide. CaO captures the sulphur of the fuel during the combustion process. The end product is a mixture of calcium sulphite ($CaSO_3$) and inert calcium sulphate ($CaSO_4$) in the ash and the sulphur dioxide emission is effectively reduced straight in the boiler. This desulphurization process is not as effective as the separate flue gas desulphurization process. Typically three times more Ca-moles than S-moles are required to reach a 90% degree of desulphurization, as compared to a ratio of 1.1–1.2 times in a downstream FGD. However, this process is simple and does not need additional equipment except the pulverized limestone feeding into the furnace.

The low combustion temperature of CFB results also in low thermal NOx formation as the emission almost exclusively comes from the nitrogen in the fuel. In this particular case, as the lignite contains a substantial amount of limestone, CaSO4, and the sulphur content of the fuel is low (Ca/S mole ratio >5), it can be expected that the sulphur dioxide emissions will be extremely low. Typically the coal injected into the furnace will have an average particle size of 1 mm and a maximum of 10 mm. There should be not more than 5% fine particles of 0.05 mm or less. Crushing of the fuel is normally executed outside of the boiler house in the fuel yard.

To start the operation the boiler needs sand to create the necessary inventory of the circulating hot mass for ignition. During normal operation the fuel ash may be sufficient to maintain that inventory level. If the fuel ash is not able to keep up the inventory level, some (quartz) sand has to be added every now and then. The fuel ash exits the boiler mostly (about 90%) in the form of fly ash and the rest is taken out in dry form as bottom ash. If the fuel has a very high ash content (>30%) special bubbling bed type ash coolers may be installed to remove the excess bottom ash directly from the bed.

Structurally, the most critical parts of the CFB-boiler are the fluidizing grate, the separator/hot cyclone and the recycling of particles from the separator/ hot cyclone. Following is a brief description of these items. The separator/

hot cyclone has experienced substantial evolution during the last 25 years. Initially it was made of heavy refractory as its operating temperature is around 900°C. It was an independent uncooled structure outside of the furnace. The thickness of the refractory did not allow fast start-up and many hot cyclone failures occurred. Erosion was also an issue. Gradually more experience has been gained in this respect. Nowadays there are designs where the separator is integrated into the furnace and its walls are water cooled membranes protected by a thin refractory. Some manufacturers (Alstom, Kvaerner, AEE) still use separate water or steam cooled cyclones even for large capacities.

This type of design requires more space than the integrated approach. To recycle hot ash and fuel mixture from the hot cyclone back to the bed requires a control device "check valve" to prevent the fluidizing air from disturbing the recycling. Typically a seal pot blocks the route. Correct flow is controlled by small fluidizing nozzles. Initially Lurgi, one of the main developers of the concept, placed some heating surfaces in the loop to cool the ash. Nowadays final superheaters can be located in this ash recycling loop (e.g., Intrex by Foster Wheeler). There the superheater is protected from possible corrosive elements in the flue gases. Regarding the maximum capacity of CFB-boilers, the development has been relatively fast. The first 100 MWe range utility type boilers firing coal were built in the late 1980s and now there are several units in the 250–300 MW range. The largest CFB in operation is the hard coal fired 350 MW unit in Sulcis, Italy by Alstom. Foster Wheeler has built several units in the 250 MW range burning wet brown coal (equal to Kosovo lignite) in Poland. All these boilers are designed for subcritical steam parameters (i.e., 160–170 bar/540–565°C with reheating).

There is one supercritical CFB-project about to start in Lagiza, Poland. Foster Wheeler will deliver a 460 MWe CFB-boiler plant for 260 bar/580°C steam parameters. The design will apply the new OTU straight tube concept. The plant is due to start up in early 2009. To summarize the status of CFB development, it can be stated that it is a proven technology up to 350 MW with subcritical steam parameters.

5.3. PRESSURIZED FLUIDIZED BED COMBUSTION (PFBC)

Fluidized bed combustion (FBC) in boilers can be particularly useful for high ash coals with variable characteristics although pressurized. PFBC has also been used on a commercial scale in Sweden and Japan with coals of higher quality (Figure 10). It is used with a combined-cycle design incorporating both steam and gas turbines. Considerable effort has been devoted to the development of PFBC during the 1990s. The other demonstration units were in Germany, Spain and the USA. FBC in pressurized boilers can be carried out in compact units, and can be potentially useful for low grade coals and

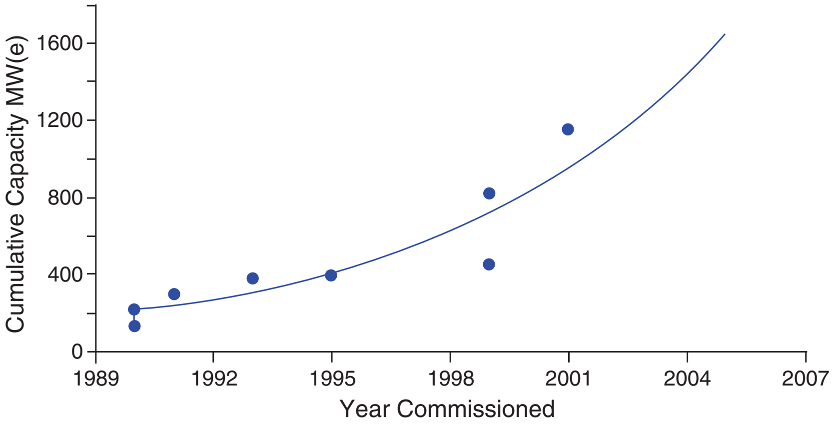

Figure 10. PFBC development over the years.

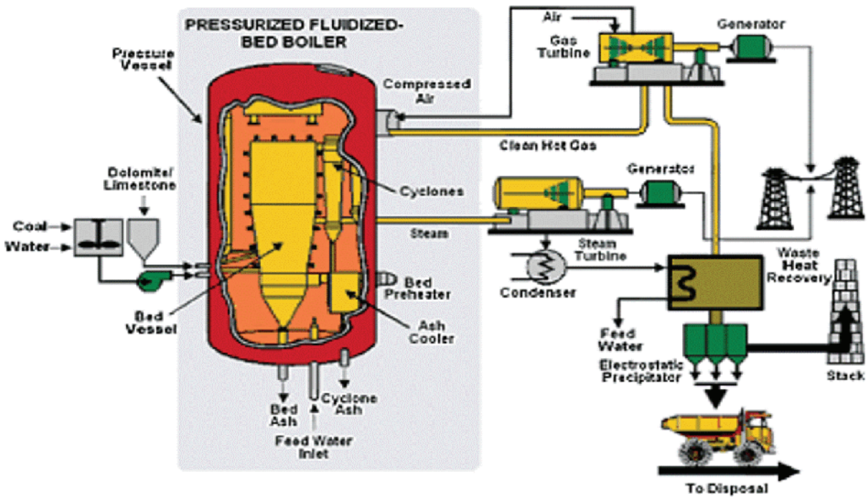

Figure 11. PFBC scheme.

those with variable characteristics. The pressurized coal combustion system generates steam in conventional heat transfer surfaces and produces hot gas to be supplied to the adjoining gas turbine. Gas cleaning is a vital aspect of the system, as is the ability of the gas turbine to cope with some residual solids in the fuel. The need to pressurize the feed coal, limestone and combustion air, and to depressurize the flue gases and the ash removal system introduces some significant operating complications (Figure 11). The combustion air is pressurized in the compressor section of the gas turbine. The proportion of power coming from the steam/gas turbines is approximately 80%/20%. PFBC and generation by the combined cycle route involves unique control considerations, as the combustor and gas turbine have to be properly matched through the whole operating range.

5.4. INTEGRATED GASIFICATION COMBINED CYCLE (IGCC)

Coal is converted into a gas ('syngas,' comprising carbon monoxide and hydrogen). The gas is then used as a fuel supply to a combined cycle gas/steam turbine plant. Emissions from IGCC are significantly lower than for a combustion-based plant as sulphur oxides, nitrogen oxides and ash/slag are removed from the fuel-gas before use. IGCC can also provide high process efficiencies approaching 50%. Carbon dioxide emissions from IGCC plants can be more easily captured than for conventional and fluidized bed plants as the carbon dioxide is in a more concentrated stream (Figure 12). This technology offers the opportunity to produce near zero emissions electricity from coal fired power plants when integrated with carbon dioxide storage. There are currently a few IGCC demonstration plants worldwide; however, gasification technologies have been widely used in the petrochemical industry for many years. Development work is underway to demonstrate this technology on a commercial scale (Figure 13).

5.4.1. Availability

The risk of low IGCC availability is still an issue. Figure 14 shows the history of availability for the demonstration of IGCC plants. It can be seen that most of the plants were able to reach the 70–80% range after a number of years. However, by adding a spare gasifier, it seems likely that IGCCs can provide

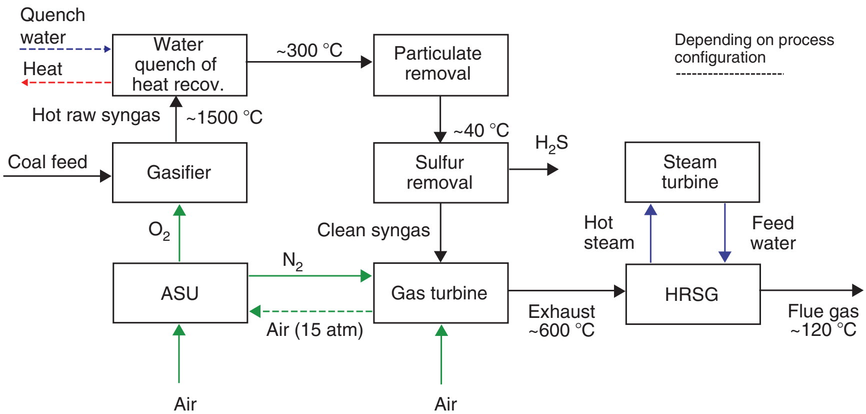

Figure 12. IGCC scheme.

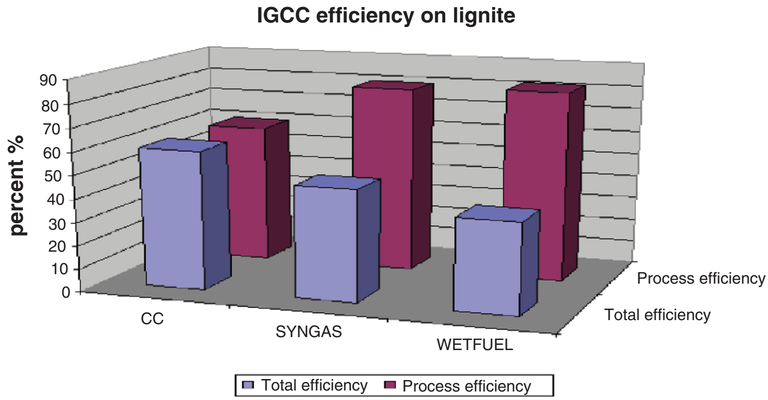

Figure 13. IGCC efficiency on lignite.

availabilities equivalent to that of NGCCs. At the Eastman Chemicals plant the gasifier has been 98% onstream over a 3 year period. According to Bechtel, the next IGCC plant should be able to achieve around 85% availability without back-up fuel or a spare gasifier.

5.5. CARBON CAPTURE AND STORAGE (CCS)

Carbon capture and storage technologies enable emissions of carbon dioxide to be stripped out of the exhaust stream from coal combustion or product stream from coal gasification and stored in such a way that they do not enter the atmosphere.

Technologies for capturing CO_2 from emission streams have been used for many years to produce pure CO_2 for use in the food processing and chemicals industry. Petroleum companies routinely separate CO_2 from natural gas before it is transported to market by pipeline. There are technical and cost challenges to be addressed in separating out CO_2 from high volume, low CO_2 concentration flue gases, such as those generated by conventional pulverized coal-fired power stations, but retrofitting (or building new) 'post-combustion' capture systems will become an economic and practical CO_2 reduction option. This can be achieved by reaction of the product stream from coal gasification in a water shift process so that carbon dioxide, rather than carbon monoxide, is produced with hydrogen. The CO_2 is captured for storage or use, and the hydrogen is combusted in a gas turbine – or, in the future, used in a fuel cell.

Geological Storage-Injection of CO_2 into the earth's subsurface offers potential for the permanent storage of very large quantities of CO_2. The CO_2 is compressed to a dense state, before being piped deep underground into natural geological 'reservoirs'. Provided the reservoir site is carefully chosen,

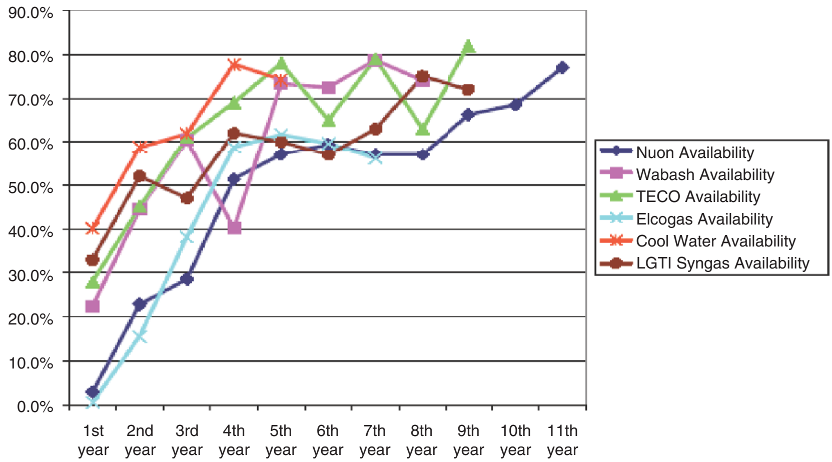

Figure 14. IGCC availability history (excluding operation on back-up fuel) (Graph provided by Jeff Phillips, EPRI).

the CO_2 will remain stored (trapped in the bedrock or dissolved in solution) for very long periods of time and can be monitored. A number of options for the geological storage of CO_2 are being researched.

5.6. EMISSION REQUIREMENTS AND ENVIRONMENTAL PROTECTION

It is assumed that the new thermal power plant (TPP) will fully comply with the EU Large Combustion Plant (LCP) rules. That will mean the following emission levels from the beginning of the operation:

Sulphur dioxide, SO_2	mg/nm^{3}200
Nitrogen oxides, NO_x	mg/nm^3 200
Particulates	mg/nm^3 30

Fluidized bed gasifiers are less developed than the two other gasified types. Operating flexibility is more limited for this class of gasifiers because they perform several functions (e.g., fluidization, gasification, sulphur removal by limestone injection) at the same time, and there are too few independent variables for the desired process optimization. Still, the fluidized bed technology perhaps offers better potential for utilizing low rank coals with high ash and moisture content.

6. Conclusions

We are facing a shortage of energy. Our towns continue to grow, increasing the need for housing. We are more and more reliant on new technology for power generation in a way that is friendly to the environment and uses natural resources efficiently. Our lifestyles demand more electricity and yet power plants are not being built. Besides, when faced with the possibility of a new power plant, no one wants one in his backyard. In the near future we will be part of the communities that must decide what to do. In order to compete with pulverized coal plants or CFB coal plants, the major challenges for new large IGCCs will be to demonstrate higher availabilities and lower capital costs. The capital cost compared to a CFB plant is especially high in a case where low grade coal such as Kosovo lignite is used. Thus, unless the IGCC investment costs drop dramatically and higher availabilities are realized, the only feasible argument for favoring IGCC over Rankin Cycle based power generation is the easier and cheaper capture of CO_2. However, in most of the cases so far, the CO_2 capturing option does not offer any advantage as there is no use for the CO_2 and the capturing and storage cost (€40–60 per ton) is well above the cost of purchasing CO_2 emission rights (€~20 per ton).

Kosovo's prosperity, standard of living and the quality of life of its citizens will greatly depend on how domestic energy resources are obtained, transformed, allocated and consumed. Hereafter the aim is to encourage energy consumption in a more rational way, use and adopt new energy technologies, and develop and provide adequate infrastructure for both the energy sector and those economic sectors that are growing. This creates a foundation for the future of the energy sector in Kosovo's economic and social context. It provides a basic framework through which Kosovo can utilize this opportunity for the benefit of all its citizens.

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CLIMATE CHANGE

CAN ENERGY TECHNOLOGIES PROVIDE ENERGY SECURITY AND CLIMATE CHANGE MITIGATION?

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Abstract: In spite of all the low carbon technologies, climate change mitigation policies, and high energy prices since the IPCC 3rd Assessment Report in 2001, greenhouse gas emissions continue to rise, and in many regions accelerate. Energy related carbon dioxide emissions, currently over 28 Gt CO_2/year, could exceed 40 Gt CO_2/year by 2030 under business as usual. To keep mean global temperature rise below 2.4°C above pre-industrial levels would require stabilisation around 450 ppm $CO_{2\text{-eq}}$, although this target is becoming very challenging to achieve. The CO_2 concentration is already at 380 ppm CO_2. Existing technologies and those close to commercialisation have the potential to reduce CO_2 emissions, the amount depending on the future price of carbon. The total global economic potential in 2030 for up to US$50/t $CO_{2\text{-eq}}$ is between 14–23 Gt $CO_{2\text{-eq}}$/year with the energy supply sector having a potential of between 3–6.4 Gt $CO_{2\text{-eq}}$/year and the potential uptake of energy efficient technologies in the buildings, industry and transport sectors contributing 9–11 Gt $CO_{2\text{-eq}}$/year. Deeper reductions are needed to meet the desired 450 ppm $CO_{2\text{-eq}}$ target, requiring social change and strong political measures to be enacted. The cost of achieving this goal is likely to be a small percentage of total GDP, but only if stringent measures are taken now.

Keywords: Climate change, greenhouse gas, emissions, primary energy, energy demand, energy technologies, renewable energy, economic potential, energy resources, distributed energy, co-benefits, bioenergy, biofuels

1. Background

The 4th Assessment Report on climate change of the Intergovernmental Panel on Climate Change (IPCC, 2007) has recently been completed (www.ipcc.ch). The Working Group III report on *Mitigation* attempted to compile the latest scientific knowledge relating to low-carbon emitting technologies; assessed the costs and potentials for greenhouse gas (GHG) emission avoidance; evaluated long term prospects out to 2,100 for stabilising atmospheric GHGs; provided a detailed list of policy options; and discussed the opportunities for sustainable development and equity linked with GHG abatement. Of the 13 chapters, that on *Energy Supply* (for which the author was Co-ordinating Lead Author) received the greatest attention with over 5,000 review comments and with the sections on nuclear and renewable energy receiving a major share of them.

Since the 3rd Assessment Report (TAR) was published in 2001, the overarching message now being delivered by Working Group III is a stronger but positive one:

Action is required. The situation is urgent – but not beyond repair. Many energy efficiency and energy supply technologies and practices to reduce greenhouse gas emissions are available now. Mitigation measures will bring many other benefits, some of which are in fact also expected to save money.

On a more negative note however, the report confirmed that since the TAR, GHG emissions continue to rise rapidly – if not accelerate – and that this is in spite of all the low-carbon technologies available, all the mitigation policies in place, the higher global energy prices, and the Kyoto Protocol having come into force.

The "long, loud and legal" government policies that would have greatly assisted the more rapid deployment of low carbon technologies in the past few years have simply not been successfully and cost effectively implemented, except in a few exceptional cases.

2. Greenhouse Gas Emissions

Emissions of the major GHGs covered by the Kyoto Protocol have increased by almost 80% from around 28 Gt $CO_{2\text{-eq}}$ in 1970 to reach nearly 50 Gt $CO_{2\text{-eq}}$ in 2004 (Figure 1). Energy-related sources from the extraction and burning of fossil fuels have been a major contributor to this growth (Figure 2). Without additional stringent policy measures, global GHG emissions are expected to continue to rise and reach somewhere between 25–90% above 2000 levels by 2030. This is instead of the preferred pathway for them to peak as soon as practical, then start the downhill trend that is clearly needed if climate change is to be overcome. Indeed many scientists are now saying that it is becoming too late to stabilise atmospheric concentrations at around 450 ppm $CO_{2\text{-eq}}$[1]

[1] 450 parts per million of all atmospheric greenhouse gases by volume when converted to carbon dioxide equivalents based on their specific 100 year global warming potentials as defined by the UNFCCC.

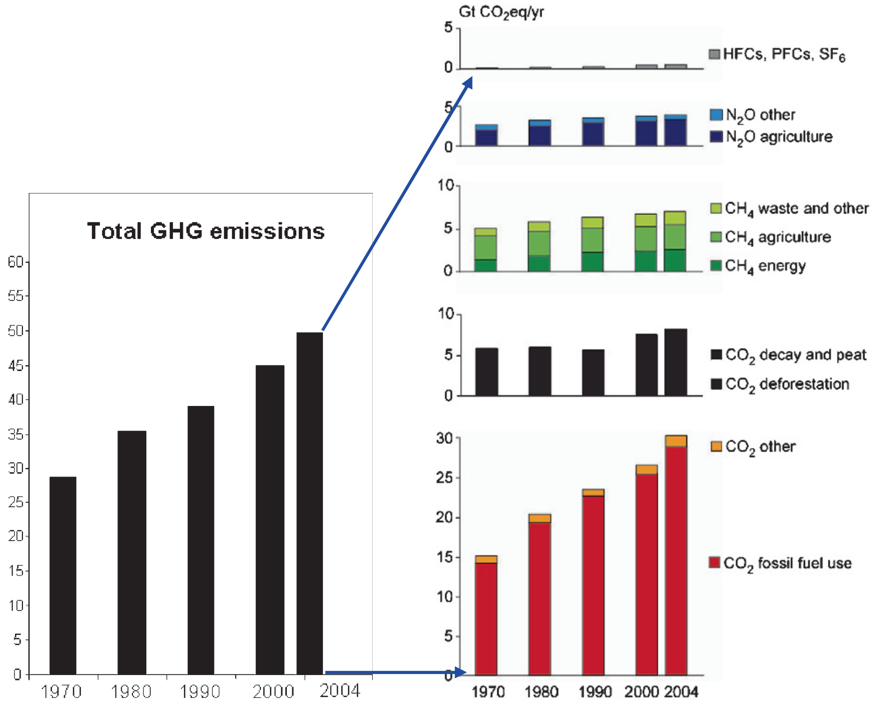

Figure 1. Global greenhouse gas emissions from all sources from 1970 to 2004 (*left*) and broken down into specific gases and sources (*right*).
Note: All gases have been converted to CO_2-equivalents based on their comparative global warming potentials

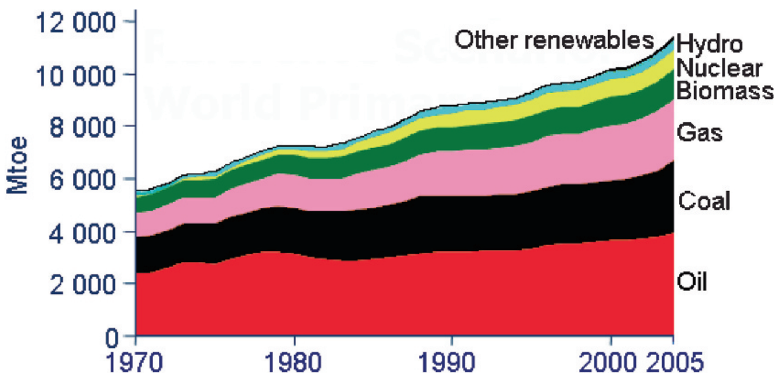

Figure 2. World primary energy demand from 1970 to 2005 showing increased dependence on fossil fuels. Biomass, nuclear, hydro and other renewables are all treated as low or zero carbon emitters (based on IEA, 2006). 1 million tonnes of oil equivalent (Mtoe) = 42 PJ.

as is thought necessary to limit global average temperature rise to around 2.4°C above pre-industrial levels, it having increased by around half a degree to date. Therefore learning to adapt and to invest more in appropriate infrastructure (flood protection, drainage, irrigation, building designs etc.) in order to cope with anticipated extreme weather events, sea level rise etc. is inevitable.

The IPCC report states: *In order to stabilise the concentration of GHG in the atmosphere, emissions would need to peak and decline thereafter. The lower the stabilisation level, the more quickly this peak and decline would need to occur. Mitigation efforts over the next two to three decades will have a large impact on opportunities to achieve lower stabilization levels.*

Working Groups 1 and II clearly showed that climate change has already begun and some adaptation is already occurring. The aim of Working Group III on mitigation was to try to identify how different stabilisation levels could possibly be achieved in practice given various possible emission reduction pathways. For each case, the potential increased cost to the global economy in terms of reduced GDP (gross domestic product) was assessed. So, for example, under a very optimistic scenario, emissions would need to peak within the next decade and then reduce quickly to reach the necessary atmospheric stabilization level range of around 445–490 ppm $CO_{2\text{-eq}}$ (Table 1). This would be a real challenge given that current GHG concentrations in the atmosphere are already at around 430 ppm $CO_{2\text{-eq}}$ (including 380 ppm of CO_2), and with no signs of abatement or related slowing down of economic growth.

To stabilize at the higher concentration of around 535–590 ppm $CO_{2\text{-eq}}$ would need emissions to peak before 2030, giving between a 2.8°C to 3.2°C average global temperature rise. However the global cost over time would be lower, at up to 2.5% of GDP by 2030 (Table 2). If however we, as a global society, are prepared to invest no more than 0.05% of our global annual GDP out to 2050 to combat this major problem, and are then willing to accept the uncertain risks of greater climate change events as the result of a 3.2–4.0°C temperature rise, then stabilizing atmospheric GHG concentrations at a very high 590–710 ppm $CO_{2\text{-eq}}$ would enable emissions to continue to rise until they eventually peak some time before 2060.

The pathways to stabilize atmospheric GHGs are numerous as shown by a wide range taken from various scenarios and categorized into six alternatives (Figure 3). The sooner mitigation measures are imposed to reduce annual emissions of GHGs, then the lower the final stabilization level becomes.

To reach the lower stabilization levels some scenarios deploy removal of CO_2 from the atmosphere (negative emissions) using technologies such as biomass energy production utilizing carbon capture and storage or soil carbon uptake through incorporation of char.

World-wide carbon prices of around US$20–80/t $CO_{2\text{-eq}}$ by 2030 could be consistent with a Category II to III type target. (A price of US$20/t

TABLE 1. Classification of recent, post-TAR, stabilization scenarios according to different stabilization targets and alternative metrics.

Category	Additional radiative forcing (W/m^2)	Atmospheric CO_2 concentration (ppm)	Atmospheric CO_2-eq. concentration (ppm)	Global mean temperature increase above pre-industrial levels at equilibrium (°C)	Peaking year for CO_2 emissions (year)	Change of 2000 global CO_2 emissions by 2050 (%)
I	2.5–3.0	350–400	445–490	2.0–2.4	2000–2015	−85 to −50
II	3.0–3.5	400–440	490–535	2.4–2.8	2000–2020	−60 to −30
III	3.5–4.0	440–485	535–590	2.8–3.2	2010–2030	−30 to +5
IV	4.0–5.0	485–570	590–710	3.2–4.0	2020–2060	+10 to +60
V	5.0–6.0	570–660	710–855	4.0–4.9	2050–2080	+25 to +85
VI	6.0–7.5	660–790	855–1130	4.9–6.1	2060–2090	+90 to +140

TABLE 2. Estimated global macro-economic costs in 2030 for least-cost trajectories towards different long-term stabilization levels out to around 2100.

Category	Stabilization levels ppm CO_2-eq	Range of total GDP reduction		Reduction of average annual GDP growth rates	
		% 2030	% 2050	% 2030	% 2050
IV	590–710	−0.6–1.2	−1–2	<0.06	<0.05
III	535–590	0.2–2.5	−0.2–4	<0.10	<0.10
I and II	445–535	<3	<5.5	<0.12	<0.12

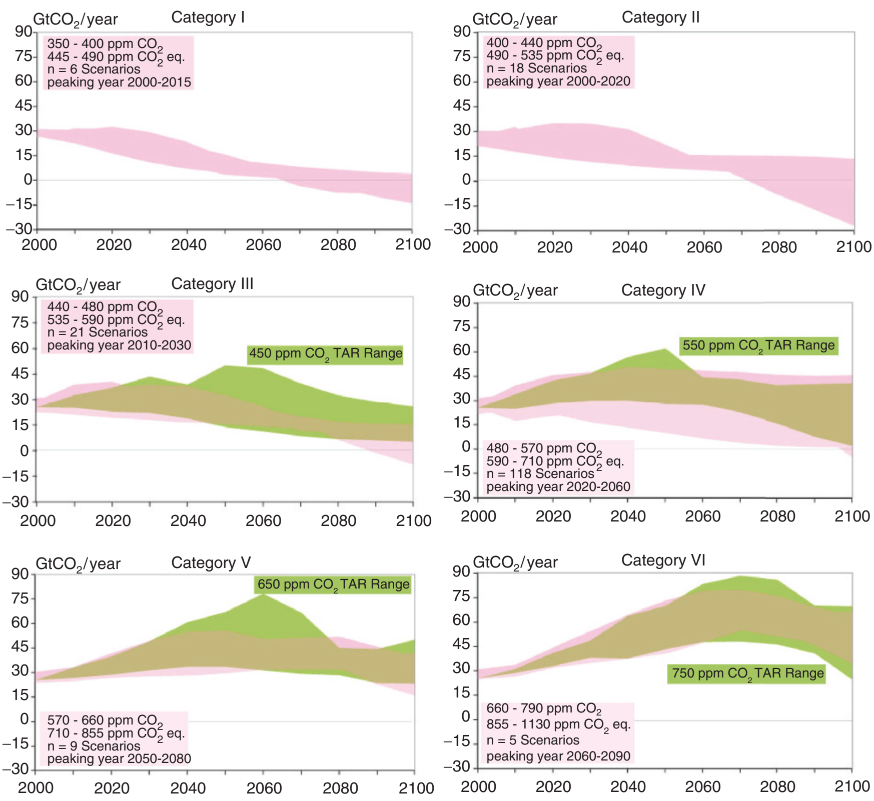

Figure 3. Emissions pathways for CO_2 emissions only, of mitigation scenarios for alternative categories of stabilization levels (Category I to VI as defined in the box in each panel). Shaded (dark) areas give the CO_2 emissions for the post-TAR emissions scenarios. Shaded (light) areas depict the range of more than 80 TAR stabilization scenarios.

$CO_{2\text{-eq}}$ equates to additional fossil fuel costs of around US$10/barrel of oil; US$0.05/l of gasoline; US$0.02/kWh of coal-fired electricity and US$0.006/ kWh of gas-fired electricity). To achieve stabilization at these low levels would cost less than 3% of global GDP in 2030. Even then this would still give a rise in average temperature of up to 2.8°C above pre-industrial levels, resulting in whatever changes to the world's climate this would inevitably bring.

Of course what the world will be like under these varying temperature increases, what the costs of adaptation and extreme weather events might be in comparison with the costs of mitigation, and what risks society is prepared to take, are the key questions that remain unanswered.

What perhaps we are now still lacking is any real sense of urgency by government policy makers, given that these IPCC analyses, and the Stern Review from the UK earlier this year clearly showed that immediate action is advisable. Overall the message is that given urgent action, acceptable emission reduction targets are achievable by deployment of a portfolio of low carbon and energy efficient technologies that are currently available and also by future deployment of those that are expected to be commercialised in coming decades.

One other significant finding from the report is that studies from all regions of the world all point to substantial health benefits by reducing GHG emissions because of associated lower air pollution – so much so that the value from the health benefits could offset a substantial fraction of the costs of GHG reductions.

3. Energy Technology Solutions

A wide range of mitigation options using a range of technologies is outlined in the IPCC report. The costs and economic potential for each sector (energy supply, transport, buildings, industry, agriculture, forestry and waste) were calculated against being above the baseline reference scenario (which is in effect business-as-usual based on existing policies already in place). Many energy efficiency measures were accounted for in the buildings, industry and transport sectors to give considerable economic potential opportunities for categories up to US$20, 50 or 100/t $CO_{2\text{-eq}}$, (Figure 4) and some even for net cost benefits (i.e. below US$0/t $CO_{2\text{-eq}}$). Where any electricity savings occurred (such as replacing incandescent light bulbs), then these were allocated to the appropriate sector (to the building sector for this example) and were not therefore double counted in the energy supply sector.

The Energy Supply chapter included key mitigation technologies and practices currently commercially available, such as improved generation plant efficiency, better distribution, fuel switching from coal to gas, nuclear power, combined heat and power, early applications of carbon dioxide capture and storage (CCS) such as removing and storing CO_2 from natural gas and renewable heat and power. In addition key technologies likely to become commercial before 2030 were included in the analysis of future mitigation potentials. These included CCS for coal-, gas-, and biomass-fired power

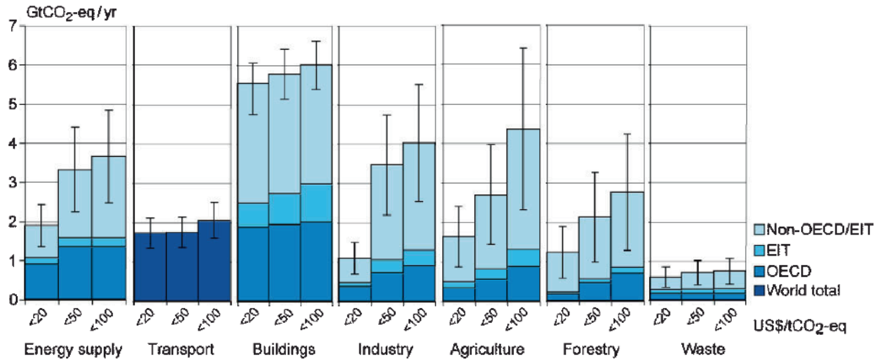

Figure 4. Estimated economic potential by sector and for global mitigation for OECD, economies in transition (EIT) and developing country regions as a function of carbon price in 2030 compared to the baseline of the Reference scenario from the IEA World Energy Outlook, 2006
Note: Ranges shown by vertical lines. Only global transport shown because of international aviation fuel. Heat, cogeneration and many of the high-cost options excluded. Emissions of electricity use are counted towards the end-use sectors and not to the energy supply sector.

generation plants; advanced nuclear power designs; ocean energy systems; concentrating solar power and efficient solar PV system designs.

So-called 'geo-engineering options' which hit the headlines from time to time, such as by inserting material into the upper atmosphere to block sunlight, adding iron to the oceans to increase carbon uptake, or placing reflecting mirrors in space, are described as 'largely speculative and unproven, and with the risks of unknown side-effects'.

More practically perhaps, the report states '*Investments in the world-wide deployment of low-GHG emission technologies as well as technology improvements through public and private research, development and demonstration would be required for achieving stabilisation targets as well as cost reductions*'. This is where energy technologies have a considerable role to play.

Fossil fuels can be partly replaced by renewable energy sources to provide heat (from biomass, geothermal or solar); electricity (from hydro, wind, geothermal, bioenergy, solar PV and concentrating solar power), CHP (combined heat and power) plants, and transport fuels. Ocean energy is still immature and was assumed unlikely to make a significant contribution to overall power needs by 2030. Net GHG emissions avoided were used in the analysis since most renewable-energy systems emit small amounts of GHG from the fossil fuels used for manufacturing, transport, installation and from any cement or steel used in their construction. Overall, net GHG emissions are generally low for renewable-energy systems (Figure 5) with the possible exception of some biofuels for transport, where fossil fuels are used to grow the crop and process the biofuel.

An attempt was made to compare the wide range of energy resources in terms of their environmental resource (based on a large number of references in the literature) (Table 3). (Note several energy sources included in the IPCC report have not been included in the tables shown).

Similarly some comparative indications of present and projected cost ranges were considered (Table 4). The wide range depicts the national/regional resource variations. Ideally, each country and state will undertake its own

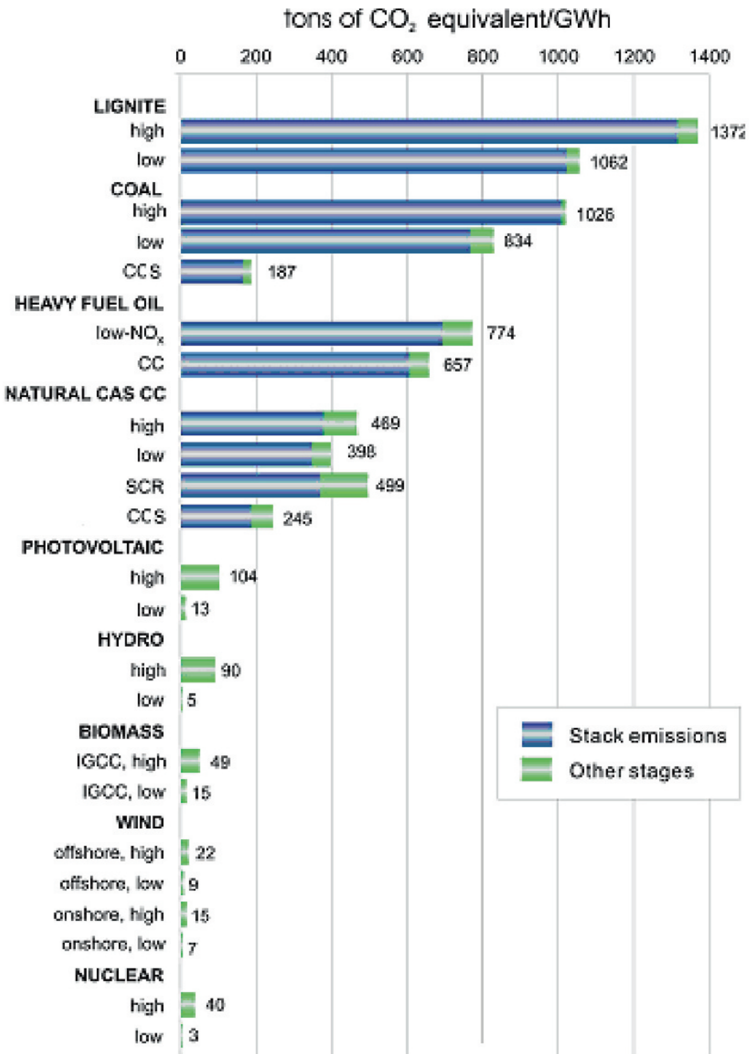

Figure 5. GHG emissions (t CO_{2}-eq/GWh) compared at the power generation plant stack and at other stages for 1 GWh of electricity generated by a range of alternative power generation technologies including coal and gas plants with carbon dioxide capture and storage (CCS) attached.

TABLE 3. Generalized data for selected global energy resources (including potential reserves), annual rate of use (from a total of 490 EJ in 2005), share of total primary energy supply in 2005, and comments on associated environmental impacts (Data aggregated from numerous sources).

Energy Class	Specific energy source	Estimated available energy resource (EJ)	Rate of use in 2005 (EJ/year)	2005 share of total supply (%)	Comments on environmental impacts
Fossil	Coal (conventional)	>100,000	120	25	Average 92.0 gCO_2/MJ
	Gas (conventional)	13,500	100	21	Average 52.4 gCO_2/MJ
	Oil (conventional)	10,000	160	33	Average 76.3 gCO_2/MJ
Nuclear	Uranium	7,400	26	5.3	Spent fuel disposition
Renewable	Hydro (>10 MW)	60/year	25	5.1	Land-use impacts
	Hydro (< 10 MW)	2/year	0.8	0.2	"
	Wind	600/year	0.95	0.2	"
	Biomass (modern)	250/year	9	1.8	Competing land-use for crops
	Biomass (traditional)		37	7.6	Air pollution
	Geothermal	5,000/year	2	0.4	Waterway contamination
	Solar PV	1,600/year	0.2	<0.1	Toxics in manufacturing
	Concentrating solar power (CSP)	50/year	0.03	0.1	Small
	Ocean (all sources)	7/year (exploitable)	<1	0	Land and coastal issues.

analysis to determine its specific mitigation costs and potentials for emission reductions using the IPCC report methodology as a guide.

4. Mitigation Potential in the Energy Supply Sector

A summary of the mitigation potential relating to energy supply and GHG mitigation costs (as outlined in Chapter 4 of the IPCC report) is given below. The potentials as presented in Table 5 are assessments for each technology taken in isolation. In reality energy efficiency measures, particularly in buildings and industry, will probably occur before 2030, thereby reducing the anticipated energy demands. Integration of energy efficiency and energy

TABLE 4. Present and projected costs (US$ 2006) in 2030 for a range of energy resources and carriers.

		Projected costs in 2030	
Energy resources and carriers	Present energy costs US$ (2005)	Investment US$/$W_e$	Generation US$/MWh
Oil	~9/GJ ~50/bbl ~48/MWh	n/a	50–100
Natural gas	~5–7/GJ ~37/MWh	0.2–0.8	40–60 +CCS 60–90
Coal	~3–4.5/GJ ~20/MWh	0.4–1.4	40–55 +CCS 60–85
Hydro >10 MW	20–100/MWh	1.0–3.0	30–70
Solar PV	250–1,600/MWh	0.6–1.2	60–250
Solar CSP	120–450/MWh	2.0–4.0	80–180
Wind	40–90/MWh	0.4–1.2	30–80
Geothermal	40–100/MWh	1.0–2.0	30–80
Ocean	80–400/MWh	?	70–200
Biomass – heat and power	30–120/MWh 8–12/GJ	0.4–1.2	30–100
Biofuels	8–30/GJ	?	23–75 c/l
Hydrogen carrier	50/GJ	?	?

TABLE 5. Potential GHG emissions avoided by 2030 for selected, electricity generation mitigation technologies (in excess of the World Energy Outlook 2006 Reference baseline, IEA, 2006) if developed in isolation and with the estimated mitigation potential shares spread across each cost range (2006 US$/t CO_2-eq) for each region.

			Mitigation potential (%) spread over cost ranges (US$/t CO_2_eq avoided)				
	Regional groupings	Mitigation potential; total emissions saved in 2030 (Gt CO_2_eq)	<0	0–20	20–50	50–100	>100
Fuelswitch and plant efficiency	OECD	0.39		100			
	EIT	0.04		100			
	Non-OECD	0.64		100			
	World	1.07					
Nuclear	OECD	0.93	50	50			
	EIT	0.23	50	50			
	Non-OECD	0.72	50	50			
	World	1.88					
Hydro	OECD	0.39	85	15			
	EIT	0.00					

(continued)

TABLE 5. (continued)

	Regional groupings	Mitigation potential; total emissions saved in 2030 (Gt CO_2_eq)	Mitigation potential (%) spread over cost ranges (US$/t CO_2_eq avoided)				
			<0	0–20	20–50	50–100	>100
	Non-OECD	0.48	25	35	40		
	World	0.87					
Wind	OECD	0.45	35	40	25		
	EIT	0.06	35	45	20		
	Non-OECD	0.42	35	50	15		
	World	0.93					
Bioenergy	OECD	0.20	20	25	40	15	
	EIT	0.07	20	25	40	15	
	Non-OECD	0.95	20	30	45	5	
	World	1.22					
Geothermal	OECD	0.09	35	40	25		
	EIT	0.03	35	45	20		
	Non-OECD	0.31	35	50	15		
	World	0.43					
	OECD	0.03				20	80
Solar PV and CSP	EIT	0.01				20	80
	Non-OECD	0.21				25	75
	World	0.25					
CCS + coal	OECD	0.28			100		
	EIT	0.01			100		
	Non-OECD	0.20			100		
	World	0.49					
	OECD	0.09				100	
CCS + gas	EIT	0.04			30	70	
	Non-OECD	0.19				100	
	World	0.22					

supply was undertaken in Chapter 11 of the IPCC Working Group III where economic potentials for each sector, with electricity being allocated to the appropriate end-use sector (Figure 4).

Annual total GHG emissions arising from the global energy supply sector continue to increase. Combustion of fossil fuels continues to dominate a global energy market that is striving to meet the ever-increasing demand for heat, electricity and transport fuels. GHG emissions from fossil fuels have increased each year since the TAR, despite: greater deployment of low- and zero-carbon technologies (particularly those utilizing renewable energy); the implementation of various policy support mechanisms by many states and countries; the advent of carbon trading in some regions; and a substantial increase in world energy commodity prices. Without the near-term introduction of supportive and effective policy actions by governments, energy-related GHG emissions, mainly from fossil fuel combustion, are projected to rise by over 50% from 26.1 Gt CO_2eq in 2004 to 37–40 Gt CO_2 by 2030. Mitigation has therefore become even more challenging.

Global dependence on fossil fuels has led to the release of over 1,100 Gt CO_2 into the atmosphere since the mid-19th century. Carrying on under business as usual could increase this figure by three or four times by 2100. To continue to extract and combust the world's rich endowment of oil, coal, peat, and natural gas at current or increasing rates, and so release more of the stored carbon into the atmosphere, is no longer environmentally sustainable, unless carbon dioxide capture and storage (CCS) technologies currently being developed can be widely deployed.

There are regional and societal variations in the demand for energy services. The highest per-capita demand is by those living in OECD economies, but currently the most rapid growth is in many developing countries. Energy access, equity and sustainable development are compromised by higher and rapidly fluctuating prices for oil and gas. These factors may increase incentives to deploy carbon-free and low-carbon energy technologies, but conversely, could also encourage the market uptake of coal and cheaper unconventional hydrocarbons and technologies with consequent increases in carbon dioxide emissions.

Energy access for all will require making available basic and affordable energy services using a range of energy resources and innovative conversion technologies while minimizing GHG emissions, adverse effects on human health, and other local and regional environmental impacts. To accomplish this would require governments, the global energy industry and society as a whole to collaborate on an unprecedented scale. The method used to achieve optimum integration of heating, cooling, electricity and transport fuel provision with more efficient energy systems will vary with the region, local growth rate of energy demand, existing infrastructure and by identifying all the co-benefits.

The wide range of energy sources and carriers that provide energy services need to offer long-term security of supply, be affordable and have minimal impact on the environment. However, these three government goals often compete. There are sufficient reserves of most types of energy resources to last at least several decades at current rates of use when using technologies with high energy-conversion efficient designs. How best to use these resources in an environmentally acceptable manner while providing for the needs of growing populations and developing economies is a great challenge.

- Conventional oil reserves will eventually peak as will natural gas reserves, but it is uncertain exactly when and what will be the nature of the transition to alternative liquid fuels such as coal-to-liquids, gas-to-liquids, oil shales, tar sands, heavy oils, and biofuels. It is still uncertain how and to what extent these alternatives will reach the market and what the resultant changes in global GHG emissions will be as a result.

- Conventional natural gas reserves are more abundant in energy terms than conventional oil, but they are also distributed less evenly across regions. Unconventional gas resources are also abundant, but future economic development of these resources is uncertain.
- Coal is unevenly distributed, but remains abundant. It can be converted to liquids, gases, heat and power, although more intense utilization will demand viable CCS technologies if GHG emissions from its use are to be limited.
- There is a trend towards using energy carriers with increased efficiency and convenience, particularly away from solid fuels to liquid and gaseous fuels and electricity.
- Nuclear energy, already at about 7% of total primary energy, could make an increasing contribution to carbon-free electricity and heat in the future. The major barriers are: long-term fuel resource constraints without recycling; economics; safety; waste management; security; proliferation, and adverse public opinion.
- Renewable energy sources (with the exception of large hydro) are widely dispersed compared with fossil fuels, which are concentrated at individual locations and require distribution. Hence, renewable energy must either be used in a distributed manner or concentrated to meet the higher energy demands of cities and industries.
- Non-hydro renewable energy-supply technologies, particularly solar, wind, geothermal and biomass, are currently small overall contributors to global heat and electricity supply, but are the most rapidly increasing. Costs, as well as social and environmental barriers, are restricting this growth. Therefore, increased rates of deployment may need supportive government policies and measures.
- Traditional biomass for domestic heating and cooking still accounts for more than 10% of global energy supplies but could eventually be replaced, mainly by modern biomass and other renewable energy systems as well as by fossil-based domestic fuels such as kerosene and liquefied petroleum gas (LPG).

Security of energy supply issues and perceived future benefits from strategic investments may not necessarily encourage the greater uptake of lower carbon-emitting technologies. The various concerns about the future security of conventional oil, gas and electricity supplies could aid the transition to more low-carbon technologies such as nuclear, renewables and CCS. However, these same concerns could also encourage the greater uptake of unconventional oil and gaseous fuels as well as increased demand for coal and lignite in countries with abundant national supplies seeking national energy-supply security.

Addressing environmental impacts usually depends on the introduction of regulations and tax incentives rather than relying on market mechanisms. Large-scale energy-conversion plants with a life of 30–100 years give a slow rate of turnover of around 1–3% per year. Thus, decisions taken today that support the deployment of carbon-emitting technologies, especially in countries seeking supply security to provide sustainable development paths, could have profound effects on GHG emissions for the next several decades. Smaller-scale, distributed energy plants using local energy resources and low- or zero-carbon emitting technologies, can give added reliability, be built more quickly and be efficient by utilizing both heat and power outputs locally (including for cooling).

Distributed electricity systems can help reduce transmission losses and offset the high investment costs of upgrading distribution networks that are close to full capacity.

More energy-efficient technologies can also improve supply security by reducing future energy-supply demands and any associated GHG emissions. However, the present adoption path for these, together with low- and zero-carbon supply technologies, as shown by business-as-usual baseline scenarios, will not reduce emissions significantly.

The transition from surplus fossil fuel resources to constrained gas and oil carriers, and subsequently to new energy supply and conversion technologies, has begun. However it faces regulatory and acceptance barriers to rapid implementation and market competition alone may not lead to reduced GHG emissions. The energy systems of many nations are evolving from their historic dependence on fossil fuels in response to the climate change threat, market failure of the supply chain, and increasing reliance on global energy markets, thereby necessitating the wiser use of energy in all sectors. A rapid transition toward new energy supply systems with reduced carbon intensity needs to be managed to minimize economic, social and technological risks and to co-opt those stakeholders who retain strong interests in maintaining the status quo. The electricity, building and industry sectors are beginning to become more proactive and help governments make the transition happen. Sustainable energy systems emerging as a result of government, business and private interactions should not be selected on cost and GHG mitigation potential alone but also on their other co-benefits.

Innovative supply-side technologies, on becoming fully commercial, may enhance access to clean energy, improve energy security and promote environmental protection at local, regional and global levels. They include thermal power plant designs based on gasification; combined cycle and super-critical boilers using natural gas as a bridging fuel; the further development and uptake of CCS; second-generation renewable energy systems; and advanced nuclear technologies. More efficient energy supply technologies such as these are best combined with improved end-use efficiency technologies to give a closer matching of energy supply with demand in order to reduce both losses and GHG emissions.

Energy services are fundamental to achieving sustainable development. In many developing countries, provision of adequate, affordable and reliable energy services has been insufficient to reduce poverty and improve standards of living. To provide such energy services for everyone in an environmentally sound way will require major investments in the energy-supply chain, conversion technologies and infrastructure (particularly in rural areas).

There is no single economic technical solution to reduce GHG emissions from the energy sector. There is however good mitigation potential available based on several zero-or low-carbon commercial options ready for increased deployment at costs below US$20/t CO_2 avoided or under research development. The future choice of supply technologies will depend on the timing of successful developments for advanced nuclear, advanced coal and gas, and second-generation renewable energy technologies. Other technologies, such as CCS, second-generation biofuels, concentrated solar power, ocean energy and biomass gasification, may make additional contributions in due course. The necessary transition will involve more sustained public and private investment in research, development, demonstration and deployment (RD^3) to better understand our energy resources, to further develop cost-effective and -efficient low- or zero-carbon emitting technologies, and to encourage their rapid deployment and diffusion. Research investment in energy has varied greatly from country to country, but in most cases has declined significantly in recent years since the levels achieved soon after the oil shocks during the 1970s.

Using the wide range of available low- and zero-carbon technologies (including large hydro, bioenergy, other renewables, nuclear and CCS together with improved power-plant efficiency and fuel switching from coal to gas), the total mitigation potential by 2030 for the electricity sector alone, at carbon prices below US$20/t CO_2-eq., ranges between 2.0 and 4.2 Gt CO_2-eq/year. At the high end of this range, the over 70% share of fossil fuel-based power generation in the baseline drops to 55% of the total. Developing countries could provide around half of this potential. This range corresponds well with the TAR analysis potential of 1.3–2.5 Gt CO_2-eq/year at US$27/t CO_2-eq avoided, given that the TAR went only up to 2020 and that, since it was published in 2001, there has been an increase in development and deployment of renewable-energy technologies, a better understanding of CCS techniques and a greater acceptance of improved designs of nuclear power plants.

For investment costs up to US\$50/t CO_2-eq, the total mitigation potential by 2030 rises to between 3.0 and 6.4 Gt CO_2-eq/year avoided. Up to US\$100/t CO_2-eq avoided, the total potential is between 4.0 and 7.2 Gt CO_2-eq/year, mainly coming from non-OECD/EIT countries.

There is high agreement in the projections that global energy supply will continue to grow and in the types of energy likely to be used by 2030. However, there is only medium confidence in the regional energy demand assumptions and the future mix of conversion technologies to be used. Overall, the future costs and technical potentials identified should provide a reasonable basis for considering strategies and decisions over the next several decades.

No single policy instrument will ensure the desired transition to a future secure and decarbonised world. Policies will need to be regionally specific and both energy and non-energy co-benefits should be taken into account. Internalizing environmental costs requires development of policy initiatives, long-term vision and leadership based on sound science and economic analysis. Effective policies supporting energy-supply technology development and deployment are crucial to the uptake of low-carbon emission systems and should be regionally specific. A range of policies is already in place to encourage the development and deployment of low-carbon-emitting technologies in OECD countries as well as in non-OECD countries including Brazil, Mexico, China and India. Policies in several countries have resulted in the successful implementation of renewable energy systems to give proven benefits linked with energy access, distributed energy, health, equity and sustainable development. Nuclear energy policies are also receiving renewed attention. However, the consumption of fossil fuels, at times heavily subsidized by governments, will remain dominant in all regions to meet ever-increasing energy demands unless future policies take into account the full costs of environmental, climate change and health issues resulting from their use.

Energy sector reform is critical to sustainable energy development and includes reviewing and reforming subsidies, establishing credible regulatory frameworks, developing policy environments through regulatory interventions, and creating market-based approaches such as emissions trading. Energy security has recently become an important policy driver. Privatization of the electricity sector has secured energy supply and provided cheaper energy services in some countries in the short term, but has led to contrary effects elsewhere due to increasing competition, which, in turn, leads to deferred investments in plant and infrastructure due to longer-term uncertainties. In developed countries, reliance on only a few suppliers, and threats of natural disasters, terrorist attacks and future uncertainty about imported energy supplies add to the concerns. For developing countries lack of security and higher world-energy prices constrain endeavours to accelerate access to modern energy services that would help to decrease poverty, improve health, increase productivity, enhance competition and thus improve their economies.

In short, the world is not on course to achieve a sustainable energy future. The global energy supply will continue to be dominated by fossil fuels for several decades. To reduce the resultant GHG emissions will require a transition to zero- and low-carbon technologies. This can happen over time as business opportunities and co-benefits are identified. However, more rapid deployment of zero- and low-carbon technologies will require policy intervention with respect to the complex and interrelated issues of: security of energy supply; removal of structural advantages for fossil fuels; minimizing related environmental impacts; and achieving the goals for sustainable development.

The cost ranges (US$/t CO_2-eq avoided) for each of the energy supply technologies (analysed independently for each technology to provide a maximum "realisable potential") in the report are compared (Table 5). The percentage share of the total potential is shown spread across the defined cost class ranges for each region and technology, assuming that a linear relationship exists between the lowest and highest costs.

Since each technology is assumed to be developed individually over time, and crowding-out by other technologies under real-world constraints is ignored, the potentials in Table 5 are independent and cannot be added together.

4.1. ELECTRICITY GENERATION

For the electricity generation sector the IEA World Energy Outlook "Reference scenario" was used as a baseline to start the analysis (Figure 6). The electricity generation related CO_2 emissions in 2002 were around 9.5 Gt CO_2 and projected to rise to around 16 GtCO_2 by 2030 as electricity demand increases from 16,074 TWh in 2002 to a projected 31,650 TWh by 2030 under "business-as-usual" and based on existing policies. Although electricity demand doubles, the Gt CO_2 emissions do not due to a changing mix of generation technologies as assumed in the baseline.

The potential for energy efficiency measures in the building and industry sectors could reduce the demand for electricity from 31,650 TWh to around 22,000 TWh by 2030, thereby reducing emissions to around 10 Gt CO_2 (Figure 6). Detailed analyses were undertaken for each technology to provide an indication of the increased capacity of new plants needed to meet growing demand; the capacity for new plants needed to replace existing stock turning over at the end of plant life; and the existing power plants assumed to be remaining in operation by 2030. The potential rate of build for nuclear, wind, ocean energy etc (including constraints from inadequately trained personnel)

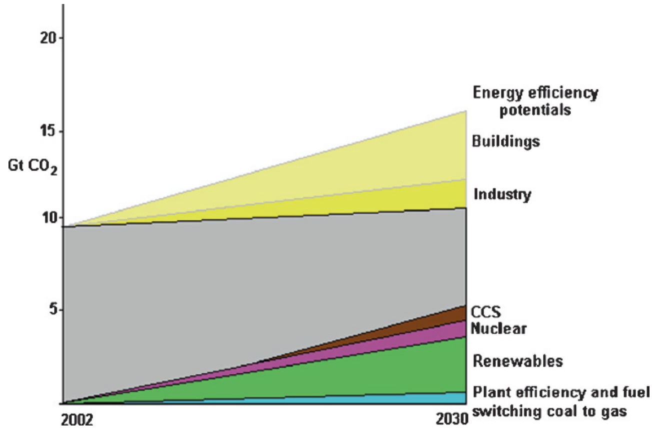

Figure 6. Increase in electricity sector carbon dioxide emissions in the IEA World Energy Outlook (2004) baseline reference scenario from 2002 to 2030. The projection could be reduced by energy efficiency, substitution for fossil fuel-based generation and the uptake of CCS after 2015, all for <US$50/t CO_2. (Based on IEA, 2006a).

was taken from the literature where possible and used to assess the electricity supply mix by 2030.

Carbon dioxide capture and storage (CCS) was assumed not to be fitted to a new commercial power plant until after 2015, and then with relatively slow growth up to 2030. Concentrating solar power (CSP) plants were assumed to be more widely deployed over this period and geothermal too, though this was constrained to 2% of electricity demand due to suitability of locations, resource consents etc.

Overall, the assumptions for a carbon price of up to US$50/t $CO_{2\text{-eq}}$ showed that nuclear power would increase from 16% of total power generation today to 18% of an expanded market by 2030. Renewable electricity at 18% today (mainly large hydro) would also increase, taking a market share of around 35% by 2030. CCS would be associated with around 6% of total generation by that time. Thus, fossil fuel generation without CCS would then account for around 42% of power generation (Figure 6), and the GHG emissions from the power sector would be reduced accordingly.

So the potential is there to halve the 2002 emissions from the electricity sector given the appropriate policies to encourage energy efficiency and to stimulate a transition to low carbon-emitting technologies.

In the IPCC report all relevant energy technologies are described in detail and reasons provided for their assumed contribution to the energy supply mix by 2030. Of the 35% share of electricity from renewable energy as projected by 2030, large and small hydro could provide around half; wind around a fifth; bioenergy also a fifth (but with a possibly greater share from adding in CHP that was not able to be analysed in detail in the report due to a lack of data in the literature); geothermal at around 1/20th (again with a possible increase from CHP applications), and CSP and solar PV having a similar combined contribution of around one twentieth.

Assessing the potentials from heating and cooling technologies was not possible simply because there is insufficient data available (IEA, 2007). Some countries have managed to ascertain the total installed boiler capacity of heat plants, achieved by surveying the name-plates of the equipment. However since a given boiler could be run for 10, 100, or 8,000 h a year and the amount of heat energy actually provided is usually not metered, then obtaining accurate heat use data is challenging. The diverse nature of heat plants makes assessment of the energy use very difficult.

Biomass and bioenergy was such a wide ranging topic that a cross-cutting group was established across several chapters (Figure 7) to identify how much biomass might become available by 2030 and whether this would meet the projected bioenergy demand at that time. Biomass can be sourced from industry, agriculture, forestry and wastes, so an assessment of the biomass resource available for energy purposes from each sector was undertaken (allowing for competition for land use, water, chemicals and materials). Conversion of the biomass into useful bioenergy was covered and the

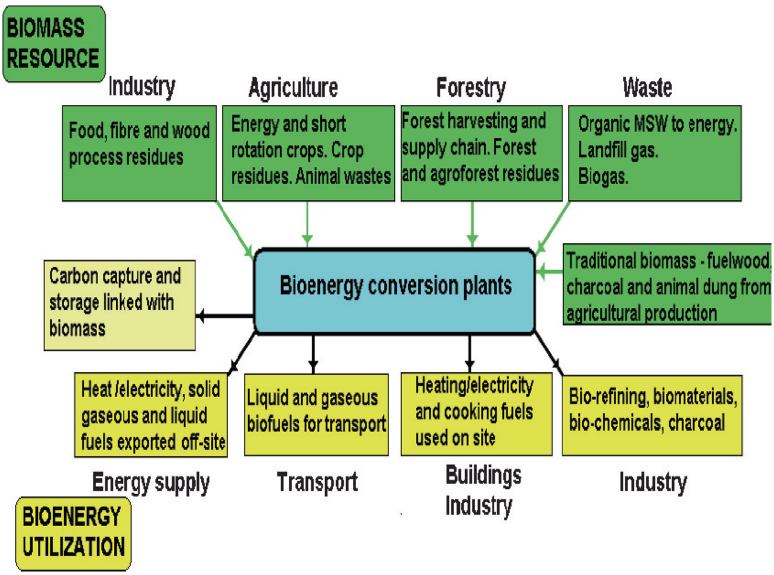

Figure 7. The biomass resource from several sources is converted into a range of products for use by the transport, industry and building sectors.

potential demand for bioenergy used by the transport, buildings and industry sectors was then assessed.

Based on this "bottom-up" approach it appears there will be sufficient biomass available up to at least 2030 to meet the growing demand for bioenergy products and services. Each country has individually to consider competition for land and water use, whether the biomass is produced on a sustainable basis, the supply chain logistics, future markets etc.

4.2. HEATING AND COOLING

The wide range of fuels and applications used for temperature modifications and the poor data base of existing heat and refrigeration plants (IEA, 2007) makes the mitigation potential for heating and cooling difficult to assess. The IEA (2006a) calculated the mitigation potential by 2030 for buildings of up to 2.6 Gt CO_2/year, including 0.1–0.3 Gt CO_2/year for solar systems, and up to 0.6 Gt CO_2/year for industry. The mitigation potentials of CHP and trigeneration (heating, cooling, and power generation) were not assessed in the IPCC report.

4.3. TRANSPORT BIOFUELS

Biofuels were a key part of the analysis with land use, resource availability, water constraints, second generation biofuels, possible blends with gasoline and diesel, all under evaluation. The result was a projection that biofuels will increase from their current 1% share of road transport fuels to around 5–10% by 2030.

Transport emissions of 6.7 Gt CO_2 in 2002 will increase under business as usual to 11.6 Gt CO_2 by 2030 but could be reduced by efficiency improvements together with the increased uptake of biofuels to emit between 7.1 to 9.4 Gt CO_2 (IEA, 2006a). Assessments for the uptake of biofuels range up to 20–25% of global transport road fuels by 2050 and beyond. In the nearer term, the Reference scenario in the 2006 World Energy Outlook (IEA, 2006) predicted biofuels will supply 4% of road fuels by 2030 with greater potential up to 7% under the Alternative Policy scenario. To achieve double this penetration, as envisaged under the WEO Beyond Alternative Policy scenario, would avoid around 0.5 Gt CO_2/year but would likely require large scale introduction of second generation biofuels from ligno-cellulosic conversions. The overall mitigation potential of biofuels by 2030 is likely to be less than from vehicle efficiency improvements (Figure 8).

This mitigation potential of between 2.2 to 4.5 Gt CO_2 however could be partially offset by the increased uptake of unconventional liquid fuels. Their potential is uncertain as, being more costly per litre to produce, they will be

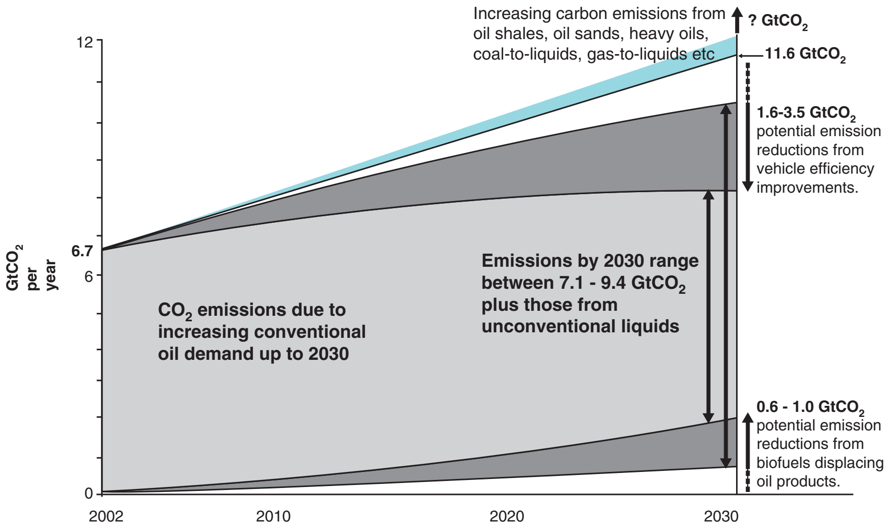

Figure 8. Potential increased emissions from the greater uptake of unconventional oils by 2030 could offset potential reductions from both biofuels and vehicle efficiency improvements but will be subject to the future availability and price of conventional oil (Based on IEA 2006a).

dependent partly on the future oil price and level of reserves. Hence overall the emissions from the transport sector up to 2030 will probably continue to rise.

5. Conclusions

Key messages from the IPCC 4th Assessment report as relating to energy supply include the following.

- Energy efficiency can be a cheaper option in terms of \$/t $CO_{2\text{-eq}}$ avoided than expanding energy supply systems. With appropriate support policies, this could significantly reduce CO_2 emissions, particularly from buildings, and reduce the costs too.
- For the energy supply sector, investment in energy infrastructure is projected to be at least US \$20 trillion between now and 2030 (IEA, 2006). Decisions made relating to heat and power plant selection will have long term impacts on GHG emissions due to the slow rate of stock turnover.
- Improved vehicle efficiency generally brings benefits and lower costs but other consumer considerations come into play. Market forces alone, including rising fuel costs, are therefore not expected to lead to significant emission reductions.

- Biofuels are projected to supply 3% of transport fuel by 2030, but changes in fuel prices and technology developments might boost this to between 5% to 10%. Uncertainties relate to the oil price, land use, sustainable production methods, genetic modification and the rate of development of new conversion technologies for second generation biofuels from ligno-cellulosic feedstocks.
- By 2020, about 30% of the projected GHG emissions in the building sector can be avoided 'with net economic benefit' since around one third of the potential is below US$0/t $CO_{2\text{-eq}}$.
- Post-consumer waste contributes less than 5% of global GHG emissions but mitigation action is possible at 'low cost' and it could also promote sustainable development. Waste-to-energy can be a useful bioenergy solution to waste treatment and disposal if air emission controls are adequately designed, installed and maintained.
- Changes in lifestyles and consumption patterns that emphasise renewable energy and resource conservation can contribute to developing a low-carbon economy that is both equitable and sustainable.
- Overall there are technologies available to help reduce the annual emissions of greenhouse gases but slow stock turnover of plant, buildings and vehicles, lack of acceptance of the magnitude of the problem by many, and the energy needed to drive the desired economic growth by developing countries are major challenges yet to be overcome. So what will the world be like when my 1 year old grand-daughter is as old as me?

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KYOTO AND BEYOND: CAN EUROPE AND THE UNITED STATES FIND COMMON GROUND ON MEETING THE CHALLENGE?

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Good morning. It is a great pleasure to be here to talk about a subject close to my heart, climate change.

Our discussion of climate change is perfectly timed with the Bali Conference just over a week away.

My topic is “Kyoto and Beyond: Can Europe and the United States Find Common Ground on Meeting the Challenge?” The unequivocal answer is yes. In fact, absolutely yes. While the press often focuses on perceived differences, an honest analysis shows the U.S. and Europe are quite close in their thinking.

First, I’ll discuss the problem of climate change in broad terms.
Second, I hope to persuade you that the U.S. is just as concerned about climate change as Hungary and others in Europe.
Third, I will emphasize that the best long-term way to reduce greenhouse gases is **both** to regulate emissions and to deploy new clean technologies.
Fourth, I will underline that U.S. efforts are aimed squarely at making the UN’s Bali process a success.

Let me begin with an unpleasant truth. The United States is a world leader in total greenhouse gas emissions. And why is this so? Simply stated, America has the world’s largest economy. Although the U.S. has only 5% of the world’s population, it accounts for 25% of global economic output. Our substantial GDP is reflected in higher levels of personal income, bigger houses, more travel, more cars, and so on.

It would be easy to say “well, stop consuming so much.” And there is no question that conservation needs to be promoted. But Americans aren’t any different from anyone else. They too want to enjoy the fruits of their labors.

Other contributions to the problem? Importantly, the population of the world is growing. Even though China’s GDP is only one sixth the size of the United States, China is about to become the world’s number one greenhouse gas emitter. We all applaud China’s rapid economic growth. Its rising living standards are critical for the welfare of its people. But China highlights the magnitude of the environmental challenges we face.

S. Stec and B. Baraj (eds.), Energy and Environmental Challenges to Security,

The problem is how to reduce greenhouse gas emissions worldwide, while populations grow, while economies develop and while personal incomes rise. The answer is not simple.

Broadly speaking, there are three ways:

1. Improve energy efficiency
2. Increase the proportion of non-greenhouse gas emitting energy sources – so called alternative energy options and
3. Learn to recapture and sequester greenhouse gases

So how much potential does each of these offer?

Efficiency is probably the most appealing because it appears to come at no cost, but this is only partly true. With some modest changes in behavior, certain efficiencies can and should be gained. But achieving larger systemic efficiencies requires investment. In Hungary, for example, many people live in older apartments where people regulate temperature by opening windows to let the hot air out. Residents have no incentive to be energy efficient, since their bills are the same whether they conserve energy or not. Without a metering system for individual apartments that provides financial benefits for conservation, efforts are likely to be quite limited. The high upfront cost of new metering systems can be a significant barrier.

Efficiency improvements also have theoretical limits. Most experts agree that efficiency alone can only reduce the amount of greenhouse gas emissions by the projected amount of emissions growth over the next 10–15 years. So, even if we were to capture all available efficiency improvements, we would still be at current emission levels in 2017.

To really **reduce** overall emissions we have to look to alternative energy and recapture or sequestration technologies. Alternative energy currently accounts for 20% of worldwide energy – up from only 15% in 1971. Most of the increase is the result of increased nuclear power. And by the way, the key to understanding France's low per capita greenhouse gas emissions is its high usage of nuclear power.

Recapture and sequestration, including clean coal and reforestation, offer great potential for the future. To that end, President Bush has moved forward with $1.6 billion in tax credits to help build nine advanced coal projects using technology that cuts emissions through efficiency and holds the promise of cost-effective carbon capture and storage.

Let's be clear. There are no easy solutions. The problem isn't going to be solved just by people turning down their thermostats and buying a hybrid car. That would help – no doubt about it – but even if everyone in the world traded in their cars for hybrids, greenhouse gas emissions would drop by less than 10%.

The solutions to the problem will come through multiple breakthroughs in technology. Fuel cells, other non-fossil fuels, rapid reforestation and brand new technologies are key.

Let me address for a moment how Americans and the U.S. Government see the climate change challenge, because I think U.S. attitudes are often misunderstood.

The United States has a long tradition of environmental activism. If you've traveled to the U.S., you probably visited one of our National Parks, which is part of a massive park system created more than a century ago. There are literally thousands of public and private programs that protect our land, waterways, and coastlines and preserve immense land banks.

The United States was at the forefront of the earliest efforts to clean-up rivers and lakes and reduce air pollution from cars and industry. The establishment of the U.S. Environmental Protection Agency (EPA) and the adoption of the federal Clean Air Act in 1970 led the world, as did specific actions like the phase-out of lead in gasoline in the early 1980s. Many of the regulatory and technological solutions employed around the world originated in the United States. These solutions often came only after long and spirited public debate. Climate change challenge is proceeding along a similar path.

In the last few years, a political consensus has been building on climate change. As that consensus has grown, President Bush has proposed increasingly ambitious programs, including regulatory mandates, tax incentives, and education campaigns.

The Energy Policy Act of 2005 established new tax rules and loan guarantee programs to encourage investment in energy efficiency and clean energy technologies.

In his State of the Union Address in January, President Bush proposed the "20 in 10" initiative, a very ambitious program to achieve a 20% reduction in fossil fuel consumption from automobiles in 10 years. This single initiative would achieve greater results than the EU's 10% biofuels initiative.

Likewise, the U.S. is leading the way in second generation cellulosic ethanol research. The first new technology plant is likely to begin running next year.

Since 2001, the U.S. Government has spent $37 billion on climate-related science, data assessment, technology, international assistance, and incentives.

An area that often gets ignored is the very significant role of the U.S. private sector. There's an old saying, if you want to know where the action is, follow the money. When it comes to solutions to the 21st century challenge of climate change, look where the big investors are putting their cash. More and more, the hard cash investors – the ones who are in it, not because they have a sense of mission, but to make a profit, are putting their money in clean technology.

As a result of all these public and private efforts, the United States is expected to avoid emitting more than 2.2 billion metric tons of carbon dioxide equivalents from 2002 to 2012. This is the equivalent to taking all U.S. passenger vehicles off the road for more than 1 year. As history has repeatedly shown, once a broad consensus emerges on an issue, the U.S. is very good at developing and implementing innovative solutions quickly.

Let me slay one common myth: Kyoto. The U.S. decision not to join Kyoto was widely interpreted as a lack of interest in addressing climate change. This simply is not true. The United States has always been a leader on international environmental initiatives. The Montreal Protocol – described by Kofi Annan as the most important and successful international environmental treaty in history – was negotiated and signed during the Reagan Presidency. It not only eliminated ozone-depleting chemicals but has already produced ten times as much greenhouse gas reductions as the first phase of Kyoto.

As for Kyoto itself, it was the culmination of a U.S.-initiated but, in the end, mostly EU-designed process. The hope was to draw-in all large economies. But it did not. The U.S. felt that Kyoto restrictions would merely result in manufacturing and jobs being shifted from the U.S. to countries like India and China, with no net reduction in global greenhouse gas emissions. The U.S. decision was based on real concerns about whether Kyoto would produce the intended results. It was not that the U.S. doesn't care about climate change.

So how are we doing?

Probably much better than many people think. During the most recent reporting period, 2000–2005, the U.S. did a better job on some measures at controlling greenhouse gas emissions than the EU. According to UNFCCC data, U.S. greenhouse emissions went up by less than 1.6%. Yet, at the same time, our economy grew by 12% – or about $2 trillion. Our population increased by 15 million people, more than one-and-a-half times the population of Hungary. According to the same UNFCCC data, during the same period, 2000–2005, EU-27 emissions increased 1.5%, almost the same as the U.S., although Europe experienced a slower rate of economic and population growth.

Another way to measure climate change performance is greenhouse gas intensity, which is the amount of greenhouse gas emissions per unit of GDP. While the U.S. economy has soared, our emissions have risen only slightly. As a result during 2000–2005, U.S. greenhouse gas intensity decreased *8.5%*. In Europe, the trend is also headed in the right direction. But progress is less dramatic, with greenhouse gas intensity falling *4.5%* for the 2000–2004 period.

In both the U.S. and Europe, CO2 emissions are starting to influence what cars people buy. The carbon footprint of this or that activity is being taken into account. And the role of nuclear power is being reconsidered, given its great potential for reducing greenhouse gas emissions.

There has also been a lot of progress in developing a range of multilateral initiatives, including:

- The Methane to Markets Partnership.
- The Asia Pacific Partnership on Clean Development and Climate.
- The Global Nuclear Energy Partnership.
- And the brand new International Clean Technology Fund – all started by the Bush Administration.
- And, of course, there is the process begun earlier this fall in Washington with the Major Economies Meeting – a process we hope will strengthen efforts to reach UN agreement in Bali. All of this reflects the strong commitment of the U.S. to the environment.

Climate change is a serious challenge, but we have had challenges in the past that seemed as insurmountable in their day. They were solved once public awareness was raised, a political consensus developed, and governments and the private sector began working together to address the problem. We are headed in the right direction. The EU and the U.S. understand the importance of bringing China, India, and all fast-growing, developing countries into a global agreement.

To that end, the United States looks forward to working with our European partners and others when the UNFCCC Conference of the Parties convenes in Bali on December 3. We hope and expect that our deliberations there will result in a roadmap that will produce a post-2012 framework by 2009. This "Bali Roadmap" should, in our view, reflect several key ideas:

One: Comprehensiveness. A future approach will be most environmentally effective if it includes all the world's major economies. Similarly, it will not be economically effective if it undermines countries' efforts to develop and achieve higher standards of living for their citizens. We have a common responsibility to address climate change, and we will all need to make appropriate contributions to achieve our common goals.

Two: Respect for diverse circumstances and efforts. Our domestic characteristics vary and a future climate framework should respect these differences. We should welcome a diversity of national plans, not a "one size fits all" approach.

Three: Accelerating the uptake of clean technologies. Advanced, low-carbon technologies are key to reducing emissions while economies grow. We need to increase support for new transformational technologies. And we need to speed the adoption of proven clean technologies.

Four: Sustainable forestry and land use. How we use our land and manage our forests have a major impact on net greenhouse gas emissions. Promoting sustainable forest management and smart land use are good for our economies and good for the natural environment.

Five: Investment. We need financing tools that support the development and adoption of new technologies. President Bush has proposed a new fund to promote international investment in clean energy technologies.

Let me conclude by underscoring the point I made at the outset. The United States is committed to working **multilaterally** to bring **all major economies** into a post-2012 energy security and climate framework. We must move toward specific, concerted, truly global efforts to fundamentally alter the way our economies work. In this way, we will support our shared dual goals of improving human development and reducing human impact on the climate.

SCENARIOS OF ENVIRONMENTAL CHANGE AND MIGRATION

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Abstract: This paper argues for a broader emphasis and complex view on environmental migration and security scenarios for examining the interlinkages both empirically and theoretically. The author notes that human and natural interactions should be taken into consideration from many of the significant aspects and conditions and looks at what different conceptual frameworks contribute to the wider understanding of environmental migration and security scenarios. The first part of the paper summarizes the security aspects of environmental migration. The second gives a very short introduction to global scenarios and their migration implications. The third describes some conceptual frameworks of environmental migration scenarios. The last section adds some remarks on environmental migration and security links. The author concludes that this link will only be understandable if the aspects of all participants are respected.

1. Security Aspects of Environmental Migration

The need to explore the link between environmental change and migration was recognised at the international level during the early 1990s. Security aspects of environmental migration are discussed both in the "environmental security" and "migration security" literature. Environmental security studies mainly focus on security issues associated with environmental degradation and climate change, while researchers of migration security deal with migration induced security problems. The "security aspects of environmental migration" appear in both approaches. In the language of mathematics one may say this is the "common set" of the two overlapping areas.

1.1. ABOUT ENVIRONMENTAL MIGRATION

Declarations made during the 1992 UN Summit on Environment and Development in Rio de Janeiro clearly recognised the importance of the natural environment to people's well-being and the links between poverty, security, population, development and environment. Agenda 21, the UN action programme, was adopted at the end of the Summit. Five years later a report of the Secretary General reviewed the progress made in the implementation of the objectives taking into account the decisions taken by the Commission on Sustainable Development on this subject. This report mentions the following emerging priority: "The need to address the interrelationships between changes in the environment and migration has emerged as a global concern, given the number of persons displaced by environmental degradation" (UN, 1997, p. 9). Ten years after Rio, the World Summit on Sustainable Development in 2002 also referred to the relationship between security, violence and the integrity of natural resources, and recognised that degradation of these resources can lead to poverty, despair and violence (UN, 2002, p. 2). Nowadays, depending on the nature of movements, one may distinguish three main types of environmental migrants: environmental refugees, internally displaced persons and voluntary migrants. Of course, the environmental component can be more or less explicitly present as motivation in other kinds of migrations like labour-migration or environmental preference migration.

Environmental refugees: The problem to be solved is paradoxical in itself. From a legal point of view, environmental refugees do not exist since they are not recognised under the 1951 Geneva Convention, or its additional 1967 Protocol. Nevertheless, NGOs and environmentalists are pushing today for a special status and protection for these refugees. Lack of academic evidence, restrictive asylum and immigration policies in industrialised countries, as well as policy-makers' scepticism, seem to have blocked the way for such a status. The United Nations Environment Program (UNEP) defines environmental refugees "as those people who have been forced to leave their traditional habitat, temporarily or permanently, because of a marked environmental disruption (natural and/or triggered by people) that jeopardised their existence and/or seriously affected the quality of their life. Environmental refugees are people who can no longer gain a secure livelihood in their homelands because of drought, soil erosion, desertification and other environmental problems, together with the associated problems of population pressures and profound poverty." (Myers, 1994).

Internally displaced persons (IDPs): The most widely used definition of IDPs is persons who have been forced to flee their homes suddenly or unexpectedly in large numbers, as a result of armed conflict, internal strife, systematic violations of human rights, natural or man-made disasters, or by dam construction and other large-scale development projects, and who are within the territory of their own country.

Voluntary environmental migrants: Although there are lots of migrants whose decision to emigrate is not really based on a voluntary decision, large portions of migration flows can be characterised as "voluntary". That may mean that the migration is motivated by, for example, the interplay of different socio-economic factors with environmental degradation or the anticipation of future environmental damage.

Estimated number of environmental migrants: It has been claimed that during the mid-1990s, up to 25 million people were forced to flee as a result of environmental change, and as many as 200 million people could eventually be at risk of displacement (Myers, 1997, pp. 167–168). The number of people fleeing environmental degradation is increasing. The highest figure is estimated by a UK agency (Christian Aid) report: "the degrading effects of climate change could displace one billion people by 2050". (Melby, 2007) The reality is that there are no scientific studies and in-depth analyses behind these estimations.

1.2. THE "ENVIRONMENTAL SECURITY" CONTEXT

The official reaction of societies to environmental problems and the potential conflicts induced by climate change can be illustrated by the appearance of the notion of climate change in national security strategies (and, of course, in policy). A comparison of these documents shows that some of them contain the words "climate change" while many others do not. No doubt the lack of such a reference can be explained by a lack of knowledge about the nature and possible scenarios of the given country's potential political, social and economic conflicts. Even those countries whose national security strategies and policies anticipate possible future conflicts in this context are aware of the real environmental threats only at a theoretical level.

In a recently published study a number of high-ranking former US generals stated that global warming will entail serious consequences for their country's national security. They demanded that climate change be included in the national security and defence strategy. In 2007, the UN Security Council debated the security-relevant aspects of global warming for the first time.

Concepts: In the late 1970s, Lester Brown and other researchers urged the redefining of the security concept and argued that national security means more than being safe from traditional military threats. Thereafter the idea of a broader concept of security began to appear in the literature. The debates of the late 1980s to the mid 1990s produced three different conceptions of environmental security –all were based on the premise that the environment posed a threat to human safety and well-being. The first is what has been referred to in environmental security circles as a "rhetorical device" (Matthew, 2000). In this case, the environment is couched in the language of security to imbue a sense of urgency and priority to environmental issues, and, many argue, gain public attention and ultimately get a larger share of national and global budgets. The second conception is one of environmental security as a subcategory of the state security framework. Environmental security in this sense focuses on examining the relationship between environmental change (with particular emphasis on resource scarcity) and violent conflict. Major issues that are examined through this lens include water wars, access to energy; environmental migration and internal conflict. The third conception of environmental security that has been adopted is one in which environmental security is seen as a new analytical framework related to human security. In this case the inputs and outputs of the equation are broadened. Environmental threats are examined in reference to their overall impact on human well-being, survival and productivity – in other words, human security. Individuals become the object that is to be secured from the adverse consequences of environmental threats (Firas et al., 2002).

Concerning the effects of global warming on security issues, the Center for Security Studies (Zurich) in a recent publication identified three trends for the next 20–30 years. First of all, there is a danger that weak states and crisis regions outside of the OECD region will become further destabilized. Secondly, many developed countries in the Euro Atlantic region will be confronted with greater challenges in the areas of crisis management, disaster relief, and domestic security due to the indirect effects of these regional destabilization processes as well as the increase of extreme local weather patterns. Thirdly, there is an emerging nexus between climate change and energy security that will affect developing countries and OECD states alike (Möckli, 2007).

1.3. THE "MIGRATION SECURITY" CONTEXT

Migration security studies mainly focus on national security issues induced by immigration to the host countries. However, it is essential both from a human rights and an ethical aspect to deal with the human security problems of environmental migrants too.

Securitizing migration: International migration has become a major domestic political issue in many countries and a major topic of international debate. Thus far, most of the attention has focused on the plight of refugees or on ways to curb the flow of illegal immigrants. As more and more migrants cross interstate boundaries, however, governments are realizing that immigration and asylum problems cannot be separated from broader socio-economic and political issues; nor can they be resolved by countries acting unilaterally. Even with this understanding, attempts to develop multilateral strategies to ease international tensions arising from uncontrolled migration will be complicated by economic disparities, regional political tensions, and mounting population and ecological pressures. Internal migration, particularly in terms of forced resettlement and urbanization, also gives rise to a myriad of problems relating to aspects of security (Graham and Poku, 1998).

Kicinger explains the aspects of the migration-security link. International migration in relation to international security can play three roles: (1) International migration can be a consequence of other security threats like human rights violations, ethnic conflict, or internal war; (2) International migration can by itself constitute a threat to international security when it is of a massive, uncontrolled character; (3) International migration can result in other security threats (e.g. xenophobia and racial violence). However, other dimensions of the migration-security nexus may also be highlighted through specifying the component of security that may be put in danger as a result of migratory movements: (1) social stability may be at risk when the inflow of immigrants is combined with a rise of xenophobia or lack of integration; (2) international migration can influence demographic security (high rates of emigration might deepen the process of the declining and aging of the population, especially in Central and Eastern European countries); (3) international migration can pose a risk to cultural identity which might be illustrated by the so-called "headscarves affair" in France or by the rising popularity of extremist right-wing parties in response to high immigration levels; (4) international migration can pose a threat to the social security system and welfare state philosophy – people might not be willing to pay higher taxes if they feel others do not, in addition to not sharing their same values which is true in the case of economically inactive immigrants and asylum seekers living on social benefits; (5) international migration might be a risk to internal security which is illustrated, for example, by higher crime levels among immigrants than among the native population, international crime networks dealing in drugs and arms, trafficking in human beings or, last but not least, terrorists using both legal and illegal migration channels to penetrate the country (Kicinger, 2004, pp. 2–3 quoting Anioł, 1992, p. 17).

Butfoy argues migration could become categorized as a security threat to the extent that host societies would perceive it as a challenge to individual, group, or national identity. Terms such as new security and common security also emerged in the academic and policy literature to encompass diverse social and economic phenomena such as migration (Butfoy, 1997). Others warn that nation states around the globe, especially Western ones, are cracking down on migration for security reasons. Indeed, the movement of people provokes anxiety and apprehension. Migration has become securitized in the vast majority of, if not all, Western states.

De-securitizing migration: Despite "securitizing" migration, authoritative reviews of scholarly literature suggest that neither bottom-up sociological perspectives nor top-down international relations perspectives have provided us with a comprehensive conceptual assessment of the relationship between migration and national security. Alexseev points out that at the global level, no empirical evidence suggests that between the late 1980s and the early 2000s the number of migrants intentionally or involuntarily undermined the security and economic performance of the host states or increased at all in proportion to the total number of international migrants around the world (Alexseev, 2005). Buzan et al. 1998, also argue that an object or phenomenon (e.g. migratory movements) can never be a threat by itself.

2. Global Scenarios and Migration

Scenarios help the researcher discover the unknown. A scenario in simple terms is a series of events that we imagine happening in the future or, in other words, scenario writing is "making up stories about the future" (Cornish, 1977, p. 11). In practice, the term "scenario" has other meanings as well. It can be used as the presentation of policy consequences, as a description of a hypothetical, likely situation or as a simple sketch of causal relationships between various actors. In some other cases the authors describe scenarios without using this term and are calling it "pattern" or "form".

2.1. GENERAL ALTERNATIVES

The term "general" in this context means the joint analysis of socio-economic, policy and environmental conditions. General (or global) scenarios can be deemed as likely situations or constellations rather than a possible series of events. Regional and country level scenarios (alternatives) can be more specific and show the plausible attributes of the storylines. Mainly three general scenarios (SRES, GSG and GEO-4) are used in the international literature but in this paper I refer only to the latest, the GEO-4.

The GEO-4 scenarios are published in the Global Environment Outlook (UNEP, 2007a). Each scenario is a narrative of a pathway into the future up to the year 2050, shaped by divergent priorities and assumptions about actions, approaches, and choices. The fundamental assumptions of the GEO-4 follow. "**Markets First**" scenario: the private sector, with active government support, pursues maximum economic growth as the best path to improve the environment and human well-being. There is a more narrow focus on the sustainability of markets rather than on the broader human-environment system. Technological fixes to environmental challenges are emphasized. "**Policy First**" scenario: government, with active private and civil sector support, initiates and implements strong policies to improve the environment and human well-being, while still emphasizing economic development. Policy First introduces some measures aimed at promoting sustainable development, but the tensions between environment and economic policies are biased towards social and economic considerations. "**Security First**" scenario: government and the private sector compete for control in efforts to improve, or at least maintain, human well-being for mainly the rich and powerful in society. Security First, which could also be described as Me First, has as its focus a minority: the rich, on the national and regional level. It emphasizes sustainable development only in the context of maximizing access to and use of the environment by the powerful. "**Sustainability First**" scenario: government, civil society and the private sector work collaboratively to improve the environment and human well-being, with a strong emphasis on equity. Equal weight is given to environmental and socio-economic policies, and accountability, transparency and legitimacy are stressed across all actors. Emphasis is placed on developing effective public-private sector partnerships not only in the context of projects but also in the context of governance, ensuring that stakeholders across the environment development discourse spectrum provide strategic input to policy making and implementation (UNEP, 2007a, pp. 400–401).

Scenario developers, for practical reasons, are very cautious in their phrasing when attempting to adapt scenario alternatives to regions or countries. However, for scientists, politicians and policymakers, regional or country futures might be much more interesting than general alternatives, hence the high interest in regional scenarios. Scenario developers employ two presentation philosophies for the challenge posed by the theory – practice duality. The typical narrative can be called "conditional specification" and can be described as follows: "if Y scenario comes true in region X then this and that happens". It is important to acknowledge that the GEO-4 scenario developers never talked about plausible scenarios. For them all four scenarios were equally relevant. The other presentation philosophy, "regional anticipation", may be described as follows: "in region X the Y scenario is the most likely and that involves this and that". In the literature the latter is much more rarely used than the former.

2.2. MIGRATION SCENARIOS

When scientists explain the "patterns" or "trends" of a specific social phenomenon the narratives used in most cases are scenario types. Thus the terms are not taken too seriously, which is – practically speaking – not a serious problem. Migration scenarios can be seen, for example, as the consequences of different policies. As a matter of fact, migration trends fundamentally depend on policies. The ideal types of migration scenarios are: (1) the "differentiation policy" that can be found somewhere between the two extremes of: (2) the "migration without borders" and (3) the "fortress world" scenarios.

The migration without borders (or 'open borders') policy describes a situation when border controls are suppressed and people are allowed to move freely throughout the world. Although the open borders scenario is frequently deemed as unrealistic, it is increasingly being discussed by NGOs, policymakers and academics. While there may indeed be little perspective for this in the near future, there are several reasons to look beyond the simplistic dismissal of free movement. **Fortress World** is a scenario developed by the Global Scenario Group. This is the only general scenario alternative that has explicit migration implications as a potential reaction to (or amplifier of?) world problems like the disparities between the poor and wealthy, worsening pollution, and last but not least, the flood of illegal migrants. The fulfilment of this concept is the "globalisation of migration control" (Düvell, 2004). Düvell warns that the tension between the right to free movement and the nation state's interest to defend its borders and control access to its territory in the last consequence is inherently a matter of life and death. The migration-security link is one of the main arguments made by supporters of the **Fortress Europe** approach and is displayed in ever stricter border controls and protection measures. Some concerns have been voiced, however, over the notion that this approach might eventually lead to greater instability in countries neighbouring the EU that would be cut off from possibilities to trade with the EU and for its citizens to work in the EU countries. This might consequently have a negative effect on the Union's security in the future (Grabbe, 2004). An opposite position was held by the Commissioner for Employment, Social Affairs and Equal Opportunities of the European Commission, Vladimir Špidla, when he declared in September 2007 that "Fortress Europe does not exist in reality and does not exist in our projects. Migrants are an opportunity and a challenge."(European Parliament, 2007). **Differentiation policy** means the filtering of immigrants initially by their skills level. In the abovementioned press release the EU Justice Commissioner, Franco Frattini, stated: "We have to look at immigration as enrichment and an inescapable phenomenon of today's world, not as a threat. We should take more account of what statistics tell us – 85% of unskilled labour goes to the EU and only 5% to the US, whereas 55% of skilled labour goes to the US and only 5% to the EU. We have to reverse these figures with a new vision and become more attractive for highly skilled workers." (European Parliament, 2007).

3. Environmental Migration Scenarios

Environmental migration scenarios describe the stories of people who have been relocated (or, in many cases, have fled) as a result of environmental degradation.

The environment may directly (e.g., tsunamis, land degradation) or indirectly (war for scarce resources) induce migration. Environmental migration scenarios can be grouped by: (1) different types of environmental problems; (2) different types of socio-economic behaviours (e.g. conflicts); and (3) regions.

3.1. MIGRATION SCENARIOS IN THE LIGHT OF THE GEO-4 ALTERNATIVES

There is a definite correlation between the three migration scenarios indicated above and the GEO-4 alternatives. This is clearly seen, for example, in the case of the "security first" scenario which evidently implies the "Fortress World" migration policy. According to Potting:

> [I]n terms of migration patterns, Markets First and especially Security First are likely to have more conflicts and inequality, provoking more and more movements of refugees and economic migrants. Whereas more openness is assumed under Markets First, barriers to migration are expected in Security First. Policy First and Sustainability First also assume more open migration, especially for refugees and displaced communities. At the same time, more equitable sharing of resources for economic development and international assistance reduce the need for migration. (Potting, 2004, p. 28).

One may ask what makes sense about a conceptual framework like GEO-4? One of the evident answers is its applicability to different countries, regions or problems (e.g., different forms of environmental degradation), since the more concretely a problem is specified, the more precisely the scenarios can be elaborated. For example, in the case of Africa, although the population increase remains an overriding driver in all scenarios, serious environmental degradation will definitely induce mass migrations initially to those countries that may have policies resembling the "Security First" scenario, which provides security only for the elite. A continuous increase in migratory pressures within Latin America, the Caribbean and North America occurs in Markets First, due to the deterioration in social conditions for many groups. Under Security First, migratory pressures considerably increase in border areas, but migratory legislation becomes more restrictive. Emigration pressures are reduced in Policy First and Sustainability First. In the latter, emigration tends to be a matter of choice rather than of necessity (UNEP, 2007a).

3.2. TYPES OF ENVIRONMENTAL CHANGE CORRELATE WITH MIGRATION

> Environmental degradation can be classified in multiple ways. A useful typology was recently published by the International Organization for Migration (IOM) in a workshop paper in which migration is associated with environmental problems. This document identifies four scenarios that show propensities to migrate in relation to environmental change through examples (IOM).

Scenario A: Migration at less advanced stages of gradual environmental change: At the early stages of environmental degradation, farmers reap fewer crops, fishermen catch fewer fish and pastoralists find ever smaller pastures for their cattle. As earning capacity begins to decline, household members may turn to internal or cross-border migration for work and to generate supplementary income transfers through remittances. They often choose temporary or circular migration because they have cultural, social or historical ties to the area of origin and/or, if poor and less skilled, are unable to avail themselves of permanent migration opportunities.

Scenario B: Migration at advanced stages of gradual environmental change: Persistent environmental degradation, which may or may not be exacerbated by climate change, may completely undermine local habitats and livelihoods. What were once temporary periods of natural resource scarcity may become more protracted or even permanent. Entire industries may collapse, leading to high unemployment and total loss of household income. Rising sea levels can present an imminent threat of displacement (IOM, 2007, p. 2).

Scenario C: Migration due to extreme environmental events: Perhaps the most familiar scenario is that of large-scale human displacement in the wake of natural and industrial disasters. While not always environmentally induced, devastating tsunamis, earthquakes and floods have left millions without shelter and basic services. In some cases, entire areas have been irrevocably damaged, making return infeasible.

Scenario D: Migration due to large-scale development and land conservation: The construction of major infrastructure works, such as dams, may involve the temporary or permanent relocation of communities. By redirecting traditional resource flows, such projects can alter human settlement and mobility and health outcome patterns. Indigenous persons and others may also be prompted to migrate by the adverse public health and environmental effects of some extractive industries. Efforts to settle nomadic populations or to conserve land have also resulted in resettlement programmes or spontaneous movements and poor population health outcomes (IOM, 2007, pp. 2–3).

3.3. ENVIRONMENTAL CHANGE, MIGRATION AND SECURITY

Assessing the nature of linkages between environmental migration and security has proven difficult. The complexity of multiple interactions and feedback processes poses tremendous empirical and methodological hurdles. The typical and most frequent approach is analyzing the potential role of environmental stress as a contributor to conflict. Work at the Peace and Conflicts Studies Program at the University of Toronto, the Environment and Conflicts Project (ENCOP) in Zurich and Bern, and the International Peace Research Institute, Oslo, among others, have all contributed towards this effort. These empirical studies have been crucial, not only in terms of advancing the scholarly discussion on the links between environmental change and violent conflict, but also in publicising the potential role environmental degradation may play as a contributor to violent conflict. Although many studies have focused on the somewhat muddled concept of environmental scarcity rather than on environmental degradation per se, the conclusion by Homer-Dixon was clear: "scarcities of renewable resources are already contributing to violent conflicts in many parts of the developing world." (Homer-Dixon, 1994). A succeeding work by Bächler demonstrated that environmental degradation and resource depletion may play a number of different, and sometimes subtle, roles in affecting security and contributing to conflict. These include environment as background to the tensions, as a channel leading to tension, as a trigger, as a catalyst or as a target (Bächler, 1998).

Some of these themes link to the approach in the Global Environmental Change and Human Security (GECHS) literature which in many ways offers a synthesis of the lessons learned in the other approaches. Vulnerabilities of populations to changing environments, and specifically concerns with the impact of global change, are the driving force in many of these studies. The welfare and survival of people and their environment is the key focus of research in contrast to the earlier focus on states and potential wars.

In parallel with the focus on the complex sources of vulnerability for poor and marginal people, the early years of the twenty-first century have returned matters to consideration of the largest scale disruptions of the biosphere, principally as a consequence of climate disruptions driven by fossil fuel consumption. Early in 2004, American media attention was drawn to a scenario exercise prepared on the part of Global Business Associates for the U.S. Department of Defence that focused attention on the importance of abrupt climate change as a possible security threat.

Reuveny also described four ways in which this environmental migration can contribute to conflict. First, violent competition can ensue between natives and migrants over local resources, especially under conditions of scarcity or when property rights are already loosely defined. Second, the arrival of migrants of a different ethnic background than the natives can threaten to shift the local region's ethnic balance, a prospect the natives may resist. Third, people in both the original and the new host country can seek to use the migrants as a foreign policy tool, especially to destabilize the other country. Fourth, the migration can exacerbate already existing conflicts over issues such as land rights, resulting in an escalation of these disputes. Reuveny concluded that the likelihood of conflict is greater if the host country is underdeveloped and if the affected communities have large income disparities (Reuveny, 2005).

Some conflicts can be interpreted as direct consequences of increased global migration, including environmental migration. The most frequently mentioned security threat the developed word faces is **terrorism** associated with Islam; international migration amplifies this danger. More analysts are accepting this idea. Proponents say, “the main danger in the world today is a new, powerfully antidemocratic and messianic force in the world, an aggressive, wounded, literally death-defying Islamic totalitarianism.” (Bernstein, 2006, p. 2). Simon warns us of the dangers of **urban warfare** and **weapons of mass destruction** (Simon, 2006). Opponents argue that we should not forget that it is a tiny number of people who finally carry out such crimes. We should not equate Islam, even in its most radical form, with terrorism; Muslims in the EU represent a marginalized group, facing high levels of unemployment, bad housing, and bad education. British studies have shown that this problem is at least partly a class issue. They are not simply Muslims but they also represent a low-class or working class; and finally, it has been shown that most terrorists were legitimate, well-integrated migrants (for example, students); they had nothing to do with illegal immigration. It means illegal immigration is not so much a security issue (Düvell, 2004).

According to some authors, and implicitly according to the Security First scenario, the **use of the military to protect borders** is a plausible answer to the problem of migration. As Steven N. Simon warned at a U.S. Senate Committee hearing on Homeland Security and Governmental Affairs: “Public insecurity over migration—particularly acute, disruptive migration events—will pressure governments to resort to vigorous measures to ensure border security … Thus, as international migration is viewed increasingly as a security concern, governments will be under greater pressure to rely on their military forces.” (Simon, 2006). Paul Smith in a recently published article posits that if climate change events become more severe, the result could be a dramatic rise in the number of international migrants. Using case studies from past and current instances where military force has been used to manage mass migrations, the author determines that the military is likely to be called upon to deal with these incidents in the future (Smith, 2007). Earlier the Millennium Project had envisaged more explicit actions, like military intervention, to protect regional or global stability. For example, some countries recognize the linkage between environmental degradation and regional stability and integrate environmental protection into their military missions. This leads to military intervention by troops on foreign soil into the forest practices of another sovereign nation (Millennium Project, nd).

3.4. ENVIRONMENTAL MIGRATION SCENARIOS BY REGIONS

Regional environmental migration scenarios originate from the adaptations of general scenarios, in our case the GEO-4. This process starts with the identification of the most likely regional scenarios or scenario combinations and continues with the specification of the environmental migration element within each. The geographical coverage varies from continents to countries (both origin and destination) to specific environmental hotspots. Regional scenarios have been developed for Europe (UNEP, 2003), Africa (UNEP, 2006), the Carpathian basin (UNEP, 2007b), the Caucasus (UNEP, 2002), etc., but little has been said about environmental migrants in each publication. Not only environmental migration scenarios but ordinary migration scenarios were cautiously discussed. However, the equal relevancy of each scenario does not follow from the above. For example, there is not too much sense to talk about the "Sustainability First" scenario concerning the near future of Russia.

4. Remarks on Environmental Migration and Security Links

Understanding the link between population movements and the security of individuals and states is particularly significant in an era of globalization. The connection between migration and security, however, is particularly challenging and problematic because migration, security and the linkage between the two are inherently subjective concepts. A number of questions have arisen in this context and the responses may contribute to the solutions.

4.1. WHO IS MIGRATING?

The answer to this question depends on who is defining the terms and who benefits by defining the terms in a given way. Matters of definition, however controversial, are central to the task of making linkages and provide a necessary entry point for analysis. Choucri has collected several factors that can complicate the definition of key terms related to migration and are captured by the following observations: (1) what you see depends on how you look at it; (2) who counts defines who is counted; (3) what is counted depends on who counts, how and why. In other words, who benefits? (Choucri, 2002).

4.2. WHOSE SECURITY?

In the domain of security, the axioms include: (1) one's security may be another's insecurity; (2) strategies designed to create security may actually enhance insecurity; (3) security may be "objective" but in the last analysis it is in the eye of the beholder, i.e., "subjective." Given the increasing politicization of migration in world politics and by definition the salience of population for politics, as well as the role of politics in national security, matters of definition are central, not peripheral (Choucri, 2002). The potential answers to the above questions can be grouped as follows.

1. Security threats of host communities: Most migration security publications concentrate on the views of the host communities: ethnic and other conflicts, increased terrorism and criminality, internal stress and unemployment are anticipated. The concept of securitizing migration is based on this hypothesis, which is not without foundation. However it is evident that the most vulnerable part of this complex phenomenon is the migrant.
2. Security threats of migrants: For migrants and their families, extreme environmental events and gradual changes in habitat have enormous human security implications. The risks to public health alone are dire and can include direct impacts such as heat stress, injuries, air pollution and cancer, plus ecosystem mediated impacts such as increased risk of infectious diseases, malnutrition, vector-, food- and water-borne diseases. Natural and industrial disasters can cause substantial damage and destruction to basic infrastructure and services. They also tend to result in prolonged family separations and disruptions to health care and education services. Displaced children and youth become more vulnerable to human trafficking, sexual and gender based violence and enlistment in criminal activities. Those who do migrate may find themselves in an irregular or undocumented situation, vulnerable to exploitation and human trafficking. The human security of environmental migrants can also be undermined by conflicts and can fuel conflicts (IOM, 2007).
3. A very specific aspect of migration security is the movement of unemployed workers to environmentally polluted or dangerous areas to find jobs. This problem raises peculiar security concerns for both the host communities and the regions from which persons are displaced.
4. Last but not least, when talking about environmental migration and its potential security implications the world must not forget the problems of the people left behind in areas of environmental damage or scarcity. A number of studies have shown that in many cases the most vulnerable people are not able to migrate. With the loss of human capital that can accompany such outward migration, the communities left behind can find it difficult to keep their schools and health clinics open. These constraints on coping capacity can in turn lead to further migration (IOM, 2007).

4.3. WHAT DOES THE EMPIRICAL EVIDENCE SUGGEST?

There is a fair bit of empirical evidence in this domain. The main sources for the concerned, mainly political, declarations are media reports, while scientists formulate concepts from the separate analyses of environmental issues and migration flows. Of course historical retrospection and some case studies confirm the correlation between environmental migration and security issues. The following hypotheses can be drawn from the above.

- For the host countries, environmental migration may pose the same security threats as traditional migration.
- Compared to legally accepted refugees, the status of environmental refugees is more threatening.
- Except in the biggest countries (e.g., China), more countries produce international environmental migrants than internally displaced persons.
- Most countries with internal environmental displacement also produce environmental refugees.
- Refugee displacement became more globalized in the post-Cold War era, meaning that more countries (both in terms of number and diversity) than ever before were affected by forced migration, including the non-developing countries of the North (in the case of the Yugoslav break-up literally at the doorstep of Western Europe) (Zolberg-Benda, 2001).
- Outside of the developed world many of the movements in fact are not out of choice. Clark argues that population movements are best thought of as a continuum from totally voluntary migration in which individual choice is paramount to totally forced migration in which the only alternative to relocation is death (Clark, 2007, p. 5).
- The differences between concrete migration patterns involving the same type of environmental degradation in various regions can be more significant than the differences between migration storylines of different types of environmental degradation within the same region. That's why talking about general global environmental migration scenarios would be misleading. On a general level nothing more can be said than that environmental degradation and climate change may induce mass-migration.

4.4. WHAT ARE THE ENVIRONMENTAL MIGRATION SECURITY RISKS IN THE EURO-ATLANTIC ZONE?

In the short run, in Europe and in the US, the direct environmental migration security effects of climate change will remain limited. It is true that vulnerable areas can expect to be affected by migration triggered by changing weather and environmental patterns, particularly in Southern and Eastern Europe. In the US, an increase of hurricane formation would cause a huge increase in the potential for damage that may cause evacuation flows. The industrialized nations will probably have the capabilities to cope with the necessary adaptation efforts. However, large groups of poor people will be seriously touched by threats of environmental migration.

Challenges to security policy in the Euro-Atlantic industrialized nations will therefore consist primarily of the indirect consequences of climate change – the effects of violent conflicts in developing countries and environmental refugee flows towards the developed regions. The results of slow-onset degradation or environmental events in sometimes remote crisis regions constitute significant threats to the domestic security of these states. They include the trade in narcotics and organized crime, human smuggling and trafficking, illegal migration, the radicalization of ethnic groups, and terrorism. These threats may continue to increase if global warming causes an intensification and expansion of conflicts in developing countries. Against the background of increasing de-territorialization – caused by globalization – and the de-nationalization of threats, the international dimension of the domestic security of industrialized nations will continue to inc rease in importance (Möckli, 2007).

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SECURITY OF THE ENERGY SECTOR IN ALBANIA IN THE FACE OF CLIMATE CHANGE

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Abstract: Recent studies carried out in the field of climate change for Albania show that climate change will affect Albania with less precipitation, an increase in temperature and a rise in sea level. More specifically, the impact of climate change is found to be significant on water resources and, in turn, on Albania's power sector which is more than 90% dependent on hydropower and, consequently, upon climate conditions. Despite all of this, the existing policy and strategic documents for the power sector do not address climate risk. There is a significant need for the country and, specifically, for the policy and decision makers of the power sector to address this issue in terms of energy security for Albania. An analysis of the Mati River Catchment Area (MRCA) as the pilot area for study, shows a high risk of reduction of the river flow which in turn results in the reduction of power generation from the hydropower plants. Urgent response measures are needed to address this finding. The paper goes on to propose a set of interventions which include a combination of alternative options such as maximizing the share of hydropower potential in the face of current and future vulnerabilities and filling the remaining gap through other alternative sources.

S. Stec and B. Baraj (eds.), Energy and Environmental Challenges to Security,

1. General Background

1.1. COUNTRY CONTEXT

Albania is a small country (land area: 28,748 km^2) with a mostly mountainous terrain and small plains along the coast. It is located in Southeastern Europe (Figure 1), bordering Serbia and Montenegro in the north, the Former Yugoslav Republic of Macedonia to the east, and Greece in the south. The country has a strategic location along the Strait of Otranto, which links the Adriatic Sea to the Ionian Sea.

The population of Albania is around 3.2 million inhabitants, with an estimated growth rate of 0.52%. Forty-six point six percent (46.6%) of the population lives below the poverty line of $2 per day. Real Gross Domestic Product (GDP) growth was estimated at 6% annually. Principal natural resources include oil, gas, coal, iron, copper, and chrome ores.

Following the fall of Communism in 1991, the country has been working to overcome its historical isolation, improve economic conditions, and introduce basic democratic reforms, including a multi-party system.

Figure 1. Map of Albania.

In June 2006, Albania signed the Stabilization and Association Agreement (SAA) with the European Union (EU) and aspires for future full membership in the Union. The SAA signing, while having a high political value, represents a clear platform for reform towards the achievement of EU standards in every aspect of political, economic and social life. The National Strategy for Development and Integration (NSDI), formulated with the assistance of the EU and other international organizations, aligns the aim of achieving the Millennium Development Goals (MDGs) and the other country goals towards EU accession for the period 2007–2013.

1.2. CLIMATE CHANGE CONTEXT

Albania is a party to the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol where it holds the status of a country not included in Annex 1, which means it is without emission reduction commitments.

The Government of Albania considers the environment as one of its most important issues and, among others, is committed to fulfilling all the obligations derived from Global UN Conventions such as UNFCCC and the Kyoto Protocol. The role of the UN has been catalytic in supporting climate change mitigation efforts in Albania. Albania is implementing a program of activities aiming to reduce the growth rate of greenhouse gas emissions, adapt to negative impacts of climate change and enable the carbon financing mechanisms under the coordination and support provided from the United Nations Development Program. The "One UN" program that Albania's Government has voluntarily joined provides new opportunities to address, among others, global environmental issues and specifically, climate change through the application of new approaches and new ways of partnership.

Climate change studies performed so far in Albania show that Albania's carbon footprint is very small. More specifically, Albania contributes an average of 7.5 million tons of CO_2/year to global GHG emissions. The above figure indicates relatively low levels of emissions compared to other developing and industrialized countries because Albania's electricity is mainly produced from hydropower sources and due to the shortage of high-energy–intensity industries. However, predictions of future emissions indicate higher growth rates of emissions – at a rate five times higher than currently, if no timely reduction measures are taken. Although Albania does not have any legal commitments for GHG emission reductions, a set of measures identified as technology needs have been identified and assessed through a needs assessment exercise. The proposed technology measures and options include the introduction and implementation of measures focused on energy saving through implementation of energy efficiency measures and promotion of renewable energy sources such as hydro, solar, thermal and wind. Adaptation technology options, both hard and soft, have also been addressed with the aim of coping with the current and expected climate variability and change.

Climate change will affect Albania through increased temperatures, less precipitation and a rise in sea level. Less rain for Albania means more droughts and less hydroelectricity, which in turn will affect the economic development of the country. Climate change will also affect tourism, agriculture, and ecosystems. Albania's coast is one of the parts of the country most vulnerable to the current and expected impacts of climate change.

With the ratification of the Kyoto Protocol Albania became eligible to host Clean Development Mechanism (CDM) projects. The first CDM project developed in Albania is an afforestation/reforestation type of project funded by the Bio-carbon Fund of the World Bank. The project will help to improve the environment and the social life of the 25 communes of Albania with the revenues to be obtained from the exchange of credits generated by the assisted natural regeneration of forests.

Albania has the potential for the cost-effective reduction of GHG emissions generated as a result of an outdated and inefficient energy sector and by developing relatively unexploited sources of renewable energy. Also, the country's proximity to the EU, electricity interconnectedness with European grids, and prospects for EU integration create market advantages to deliver CDM projects in Albania.

2. The Purpose and the Scope of the Paper

The paper summarizes the findings of a study carried out with the aim to analyze the impact of climate change to hydropower generation and identification of response adaptation measures.

The paper is focused on Albania's power sector, more specifically on Albania's hydropower sector. The reason for such a selection derives from the significant impact of climate variability and its extreme events on Albania's hydropower generation which is currently dominated by hydropower output at over 90% levels which can meet 50% of its electricity needs. The paper considers findings from previous studies showing severe impacts of climate change on water availability due to reduced total runoff formation by 10%, with a projected reduction of up to 30% by mid century. This definitely will have a continued impact on the country's generation of electricity. Albania is currently undergoing the deepest energy crisis in its history reflected by the interruption of energy supply at a daily average of 6–8 h per day and 16–18 h in rural areas.

In June 2003, Albania developed a National Energy Strategy, currently under the review phase, that puts together a long term investment plan in the energy sector. It states that only 35% of Albania's hydropower potential has so far been exploited. The strategy acknowledges the impact of recent droughts on the supply of electricity; however the Energy Strategy does not consider climate risks under the future scenario development for the hydropower sector.

The study is focused on a selected priority system/area, namely the Mati River Catchment Area (MRCA). The selection of the MRCA as a priority system for the study resulted from an evaluation exercise conducted according to a set of criteria.

The study is carried out in the frame of the project titled "Enhance regional South East European (SEE) cooperation in the field of climate policy" funded by the Regional Environmental Center for Central and Eastern Europe (REC). The study is also in line with and complements the on-going studies on vulnerability and adaptation for Albania carried out under the national communication exercise with the support of the United Nations Development Program (UNDP).

3. Methodological Approach

For the sake of the analysis of climate variation, its extremes and trends, the entire basin of the Mati River is conventionally divided into two homogenous parts (from a climatologic viewpoint). The lower part lies around the mouth of the river on the seacoast and the upper one (mountainous part) extends to an average altitude of 600 m.

The current trends of temperature, precipitation and runoff are identified by calculating the seasonal and yearly anomalies from the long-term averages (1961–1990).

Climate change scenarios are prepared by using the updated version of MAGICC/SCENGEN (version 4.1). The global model for the Assessment of GHG Induced Climate Change (MAGICC) is run by using the following scenarios from different SRES families: A1BAIM, A2ASF, B1IMA, and B2MES. They are markers of respective families (SRES A1, SRES A2, SRES B1, and SRES B2).

To develop the climate scenarios, the change fields are used, scaled in SCENGEN by the global-mean temperature change derived from MAGICC. The temperature and precipitation changes are generated for each emission scenario for years 2025, 2050 and 2100. The GCMs: CSM_98, ECH395, ECH498, GFDL90, HAD295, HAD300 are used.

To evaluate the effects of likely changes of climate on runoff, a hydrological rainfall – runoff model was applied. The precipitation and temperature input into the model was spatially averaged over the basin using the Thisean method for precipitation and the arithmetic mean for temperature. The model, which considers the likely changes in evaporation and runoff, was calibrated with data for the standard period 1961–2000.

For the development of scenarios (baseline and alternative) for Albania's power sector, the Long Range Energy Alternatives Planning (LEAP)[1] software has been utilized. More specifically the LEAP software has enabled the development of the scenarios that follow.

The Power Baseline Scenario: This scenario assumes the preservation of the current terms of supply and demand for energy for all sectors as well as assumes the continuation of the same consumption patterns of electrical power in households and services. It takes into account the measures which the government has decided to undertake for the short-term period (till 2010). It takes into account the non-rigorous implementation of the Electrical Power sector's action plan by indicating that this non-implementation puts the energy sector in considerable difficulty generally and the electrical power sector specifically. This scenario does not consider climate change impact on Albania's power sector development and specifically on the hydropower sector.

The Power Alternative Scenario: This scenario involves the stability of Albania's energy sector development in general and electricity sector in particular by rigorously implementing the Power Sector Policy Statement up to the year 2010. The Alternative Scenario describes additional measures (besides those provided by the Statement) required by the year 2010 (especially for the other sectors not analyzed by the Statement) and for a longer term period: 2010–2030. The Scenario provides a quantitative description of the measures needed to take the needed adaptation measures.

As highlighted throughout the previous vulnerability studies there is an impact of climate change on the generation of the HPPs. A thorough

[1] LEAP is a scenario-based integrated energy - environment modeling system designed and disseminated by the Boston Centre of the Stockholm Environment Institute. Its methodology is based on a comprehensive accounting of how energy is consumed, converted and produced in a given region or economy under a range of alternative assumptions on population, economic development, technology, price and so on. With its flexible data structures, LEAP allows for analysis as rich in technological specification and end-use detail as the user chooses. At the heart of LEAP is the process of scenario analysis. Scenarios are self-consistent storylines of how an energy system might evolve over time in a particular socio-economic setting and under a particular set of policy conditions. Using LEAP, scenarios can be built and then compared to assess their energy requirements, social costs andbenefits and environmental impacts. For more information on LEAP visit the website:
http://www.seib.org/leap

analysis has been undertaken of the priority system of MRCA in terms of analyzing the impact of river flow depletion on power generation, presented in more detail in the following sections. A statistical correlational method has been applied in order to determine the correlation between river flow and hydropower generation in the MRCA.

The selection of the priority sector of MRCA and the selection of the adaptation priority measures needed to address the vulnerability of the hydropower sector to climate change have been evaluated through a multi-criteria analysis. As explained in the previous section, the selection of the MRCA as a priority system for the study has been conducted through an evaluation exercise according to a set of criteria. The criteria consist of the following:

(i) Scale of vulnerability to climate change

(ii) Relevance to national development priorities

(iii) Range of benefits brought to national development and

(iv) Availability of data to conduct a study over the area

The selection of the priority adaptation measures has been done as per the following criteria and sub-criteria defined and validated through consultation processes with experts and stakeholders:

- Promotion of sustainable development
    - *(i) Security of energy supply*
    - *(ii) Environmental protection*
    - *(iii) Regional development*
- Reduction of vulnerability
    - *(i) Minimize risk*
    - *(ii) Minimize economic losses*
    - *(iii) Increase institutional response (in the case of spill water)*

These crit eria have already been used to some extent in the selection of the adaptation technologies in both processes – that of preparation of the previous climate change studies, such as Albania's First National Communication (FNC), and Albania's Technology Needs Assessment (TNA). After being validated through a wide consultation process with the relevant stakeholders the criteria were reviewed and updated as per the current conditions and developments in the relevant concerned sectors and consequently applied to the evaluation and selection of the adaptation measures identified under this study. The review and update process involved the review/update of the scoring and weighing of the criteria as well.

4. General Information on the Selected Area and Sectors Under Analysis

4.1. MATI RIVER CATCHMENT AREA

4.1.1. General Features

The MRCA lies in the Lezha, Kurbini, Mati and Mirdita Districts. Lezha region is one of the poorest regions in Albania. The population in 2005 was estimated at 95,260 inhabitants, 70% of which reside in rural areas. This region has seen an influx of inhabitants from the mountainous areas of the country that seek to move to the coast. However, the region is also affected by emigration with 40.6% of families having at least one member abroad. Lezha is among the regions with a mid-level human development index (HDI): Lezhë and Kurbin at 0.798, and Mirdita at a lower HDI of only 0.632. The unemployment rate of 28% is about twice the national average (14.4%), which is an indication of the high level of poverty in the region. Fifty one percent (51%) of the labor force is engaged in the private agriculture sector (this includes fisheries), 35.3% in the private non-agriculture sector, and 13.7% in the state sector. Tourism and agriculture are two important sectors with an impact on the economic growth of the region.

The current conservation regime in the Mati river delta consists of three surrounding protected areas: Kune (800 ha), Vain (1,500 ha), and Patok-Fushe Kuqe (2,200 ha). These areas have been classified as IUCN Category IV protected areas – managed nature reserves.

4.1.2. Geography

The Mati River (see Figure 2) is an important river in Albania. It is composed of two main branches, Mati and Fani, which have approximately equal catchment areas and inflow. This hydrographic basin is of significant economic importance for its energetic and irrigation advantages.

The relief of the watershed is mountainous and fractured with valleys and deep gorges. The MRCA, before it joins the Fani River, is 1,329.8 km^2 and the total area is 2,488.2 km^2. The Fani River has a catchment area of 1,075.6 km^2. After the construction of the artificial Lake of Ulza (1957) and the hydropower facility of Shkopeti, the natural water regime of this river is mostly affected by energy plans for water use.

After the joining of the two rivers near the Miloti Bridge, the Mati River reaches a width of 484 m representing a typical plain river with low relief.

The Mati River springs from the mountainous region of Kaptina-Martanesh, well-known as a karstic zone, with an altitude of 1,873 m above sea level. There are several streams along the river which nourish the Mati

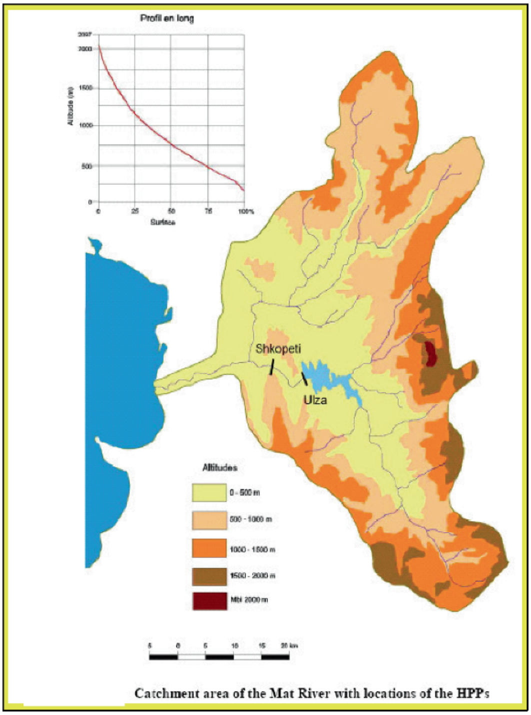


Figure 2. Map of study area: catchment of Mati river.

water flow. Some of them are permanent and the others only seasonal. The water basin is covered mainly by pine and oak wood.

The Mati River meanders from east to west and from north to south before reaching the Adriatic Sea. From the large amount of sediment transported by this river the Patoku lagoon has been formed, having a surface area of 5 km^2. The long-term average discharge of the Mati River is Q = 87.4 m^3/s and the total volume of water flow is W = 2,756 × 10^6 m^3 per year.

Evaluating the influence of the lithological and geological factors, it is important to underline that in the Mati watershed limestone formation helps in underground recharge and the creation of karstic springs in the upper and central portions of the watershed and the alpine lake in the mountain region of Batra, Zhura, Mali me Gropa. The overall situation enables and increases the potential for evolution of a hydrographical network with a sustainable water flow even in the dry season. The main springs of this region are the springs of Preshi, Shuteria, Vinjolli, Shenllia, etc.

From the geological point of view, the flatland portion of the watershed is composed of alluvial layers created from the continuous deposition of the sediment transport of the river with good permeability.

The underground waters in this region bear the impact of climatic and human conditions. Human intervention to make use of these resources by, for example, building artificial reservoirs for irrigation has led to an artificial rise of the water table, while on the other hand drainage or channel dredging may cause the water table to go down.

During the 1980s the river channel was regulated with the aim of protecting the fields from flooding. But in the last few years an intensive and aggressive use of the river aggregates has taken place in the Mati River terraces and even its bed. This phenomenon plus the deforestation that occurred in the watershed have a negative influence on the sustainability of the river bank with the consequences of erosion destroying mostly the hydro-techniques works and the equilibrium of the river bed. The Mati and Fani River waters are used not only for irrigation but to recharge the underground reservoirs to be used later for drinking water as well (Fushe Kuqe, Shenkoll etc.).

4.1.3. Energy Potential

There are two HPPs set up in the MRCA, namely, Ulza and Shkopeti as shown in Figure 3. The main characteristics of the MRCA are listed in Table 1.

The following table shows the main characteristics of the MRCA.

Ulza HPP is located in the Mat River Valley, near the villages of Ulza and Burrel. Ulza dam is a concrete gravity dam with a straight axis. The main characteristics of the Ulza HPP are listed in Table 2. The reservoir created by the Ulza dam serves as the head pond for the MRC. With a total storage of 240 million cubic meters, it is adequate for annual regulation (Figure 4).

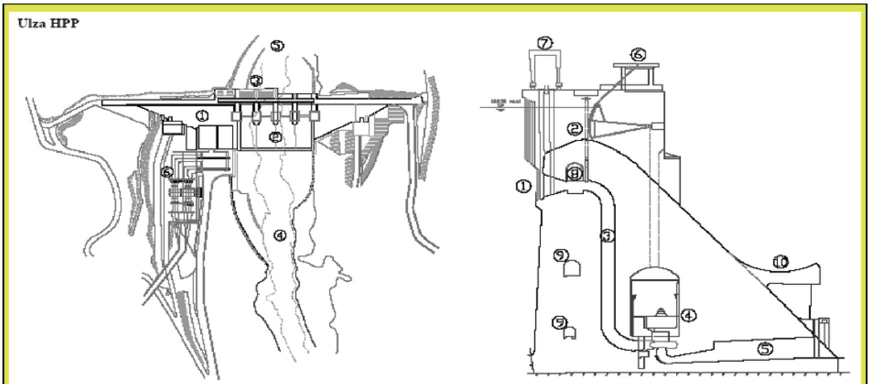
Shkopeti Hydro Power Plant

Shkopeti HPP is located in the Mat River Valley, downstream of Ulza HPP, and near Shkopet village (Figure 5). The main characteristics of the Shkopet HPP are listed in Table 3.

Figure 3. Satellite image of Mati river.

TABLE 1. Main characteristics of Mat river cascade.

Items	Ulza	Shkopeti	Cascade
Construction period	1952–1958	1958–1963	
Location			Mat river
Near the village	Ulza	Shkopet	
Position in the river cascade	High	Low	
Dams			
Number of dams	1	1	2
Type	Concrete gravity	Concrete-arch gravity	
Protection against water filtration	Grout curtain	Grout curtain	
Height (m)	64.2	52.2	
Crest level (m asl)	131.7	77.2	
Crest length (m)	260	88.31	
Dam volume (m^3)	260,000		
Reservoir			
Water max. level (m asl)	128.5	74.8	
Water min. level (m asl)	117.0	60.2	
Annual inflow (million cubic meters)	1,168	1,168	
Active storage (million cubic meters)	240	40	280
Discharge capacity			
Units			
Number of units	4	2	6
Plant power (MW)	4 × 6.25 = 25	2 × 12.5 = 25	50
Plant outflow (m^3/s)	4 × 16	2 × 40	
Nominal net head (m)	53.7	36.8	90.5
Annual production (GWh)	120	94	214



Layout of Ulza HPP. ①: concrete gravity dam, ②: spillway, ③: power waterway intake, ④: Mat River, ⑤: reservoir, ⑥: switchyard.

Cross section of Ulza Dam. ①: intake, ②: spillway gate, ③: pressure pipes, ④: power house, ⑤: downstream channel, ⑥: hoisting device, ⑦: gantry crane, ⑧: valve chamber, ⑨: control galleries, ⑩: flip bucket.

Figure 4. Ulza HPP layout.

TABLE 2. Main characteristics of Ulza HPP.

Hydrology	Catchment area	Main power plant data
Reservoir	Mean flow	37 m^3/s
	Total storage	240 million cubic meters
	Active storage	124 million cubic meters
	Mean annual inflow	1,170 million cubic meters
	Max. water level	129.50 m asl
	Max. operation water level	128.50 m asl
	Min. operation water level	117 m asl
Dam	Type concrete	Concrete gravity dam
	Type of sealing	Grouting curtain
	Crest level	131.70 m asl
	Level of valley floor	75.00 m asl
	Min. foundation level	67.50 m asl
	Crest length	260 m
	Max. dam height above foundation	64.20 m
	Volume of material	260,000 m^3
	Period of construction	1952–1958
	Date of first filling	1957
Spillway	Type/number	Four openings with radial gates, adjacent chute and flip bucket
	Crest level	120.50 m asl
	Capacity	2,160 m^3/s
	Maximum flood flow	1,200 m^3/s
Bottom outlet	Type/number	Definitely closed
Intake	Type/number	Four submerged intakes
	Crest level of intake	109 m asl
Pressure circuit	Type	Conduits integrated in dam body
	Diameter	2.40 m
Powerhouse	Type	Incorporated in the dam
	Location	Within the body of the dam
	Level of machine hall	80.35 m asl
	Max. tailwater level	85 m asl
	Plant flow	4 × 16 m^3/s
	Nominal head	54.80 m
	Number/type of turbine	Four vertical Francis
	Installed capacity	4 × 6.3 MW
Annual energy output	Mean	120 GWh
	Plant factor	51%
Dam monitoring equipment	Piezometer	Ten piezometers

(continued)

TABLE 2. (continued)

Hydrology	Catchment area	Main power plant data
	Pendulum	None
	Pressure cell	None
	Altimetry measurement	Benchmarks/geodetic targets
Drainage and dewatering system	Number of drains	Piezometers used as drains
		One every 3 m approximately
		One drain per joint between blocks
	Seepage measurement	No

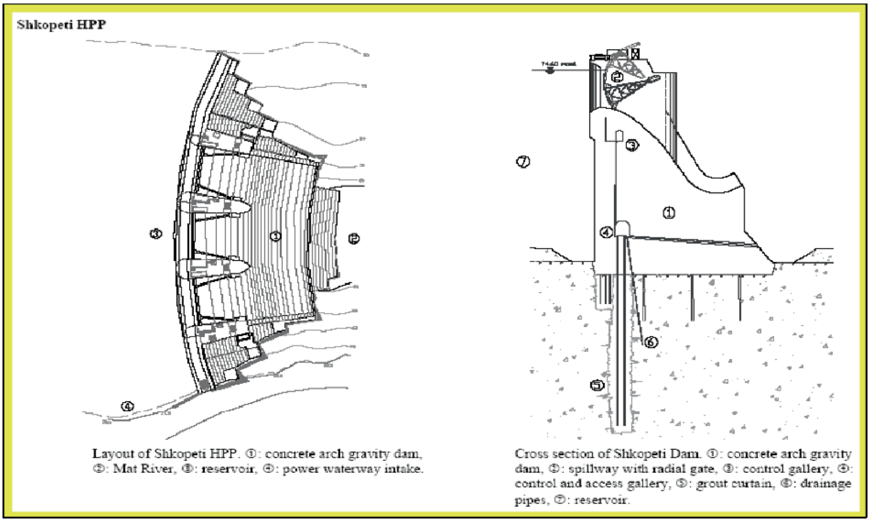


Figure 5. The Shkopeti Hydro Power Plant

4.2. PROGRAMS AND INVESTMENTS IN THE HYDROPOWER SECTOR FOR MRCA

The government of Albania is promoting private investment in the hydropower sector. The adoption of the law on concessions opened the way for private investment for rehabilitation and construction of HPPs. Through loans and grants a group of donors is currently funding the rehabilitation of some parts

TABLE 3. Main characteristics of Shkopeti HPP.

Hydrology	Catchment's area	Main power plant data
	Mean flow	37 m^3/s
Reservoir	Total storage	40 million cubic meters
	Active storage	10–15 million cubic meters
	Mean annual inflow	1,170 million cubic meters
	Max. water level	74.60 m asl
	Max. operation water level	74 m asl
	Min. operation water level	63 m asl
Dam	Type	Concrete gravity dam
	Type of sealing	Grout curtain
	Crest level	77.20 m asl
	Level of valley floor	29 m asl
	Min. foundation level	25 m asl
	Crest length	89 m
	Max. dam height above foundation	52.20 m
	Period of construction	1958–1963
Spillway	Type/number	3 openings with radial gates, adjacent chute and flip bucket
	Crest level	66.60 m asl
	Capacity	5'250 m^3/s
Bottom outlet	Type/number	None
Intake	Type/number	Submerged intake
	Crest level of intake	Unknown
Headrace	Type	Concrete lined tunnel
	Section	5.20 m
	Length	288 m
	Mean velocity	4 m/s
Pressure circuit	Type	2 shafts
	Diameter	2.6 m
Powerhouse	Type	Outdoor
	Location	300 m downstream of the dam
	Plant flow	2 × 40 m^3/s
	Nominal head	38.50 m
	Number/type of turbine	2 Kaplan
	Installed capacity	2 × 12 MW
Annual energy output	Mean	90.2 GWh
	Plant factor	41%
Dam monitoring equipment	Piezometer	3
	Pendulum	None
	Pressure cell	None
	Altimetry measurement	Benchmarks/geodetic targets
Drainage and dewatering system	Number of drains	1
	Seepage meas urement	**No**

of the machinery and equipment in the existing HPPs, mainly in the Drini and Mati river cascades. These rehabilitation investments, worth US$40 million, have the main goal of increasing the reliability of these HPPs.

Since January 2007, the KfW started a 26 month programme called the Renewable Energies and Energy Efficiency (EE) Promotion Programme to support Albania in the fulfillment of the Action Plan of the NSE. The overall objective of the Renewable Energies and EE Promotion Programme is to contribute to economic growth and to enhance the productivity of the Albanian economy. The Programme's purpose is to contribute to an improvement and extension of electricity supply, strengthen grid stability, reduce system losses, realize energy savings and thereby to protect the climate and environment through the efficient generation and use of energy. The Programme consists of three components:

- The Renewable Energies Facility (REF) (up to €3.5 million) shall facilitate the extension of loans by local commercial banks to finance investments in the rehabilitation, expansion or construction of SHPPs by providing partial credit guarantees.
- In parallel, measures shall be taken to enhance EE, which shall promote (up to €3.5 million) the selection of demonstration measures with high visibility, in particular those benefiting disadvantaged strata. This should cause a multiplier effect and ensure a high benefit for end-users.
- Accompanying measures shall assist with programme implementation (for this, consultants are recruited).

5. Current Climate Variability in the MRCA

The climatic variability of the MRCA is analyzed based on the long-term series recorded by the meteorological stations located within and close to the MRCA.

5.1. SOLAR RADIATION AND SUNSHINE DURATION

The annual total amount of solar radiation is around 1,490 kWh/m^2 and 1,420 kWh/m^2 respectively over the low and hilly parts. It is clearly evident that this indicator represents a considerably high value (compared with the maximum value of 1,570 kWh/m^2 reached in the southwest part of the country – Fier).

As far as sunshine duration, there is an average of 2,580 h/year registered in the low parts and 2,390 h/year in the hilly parts.

Figure 6 illustrates the inter-annual course of solar radiation and sunshine duration in the low part of the area studied. Both indicators have similar courses, reaching the maximum values during summer and the minimum in winter.

5.2. TEMPERATURE

The annual mean air temperature is registered at around 15.0°C over the low part and 13.4°C over the hilly part. It varies from 6.2°C to 3.9°C in the coldest month (January) for the low and hilly parts and from 23.6°C to 22.8°C in the warmest month (July) respectively.

The mean maximum varies from 11.0°C to 9.0°C in January and from 29.4°C to 30.0°C in August respectively over the low and hilly parts. The mean minimum value of temperature varies from 2.8°C to 1.2°C (January) and from 18.2°C to 15.6°C (July) for the low and hilly parts respectively. Figure 7 shows the annual course of these indicators for the low part. There is a similar distribution for the hilly part as well.

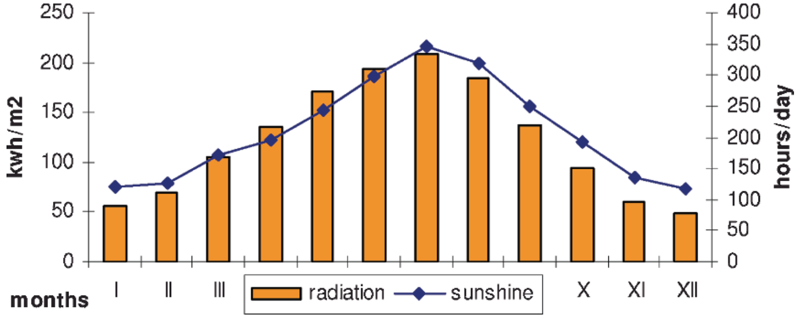


Figure 6. The annual course of solar radiation and sunshine duration.

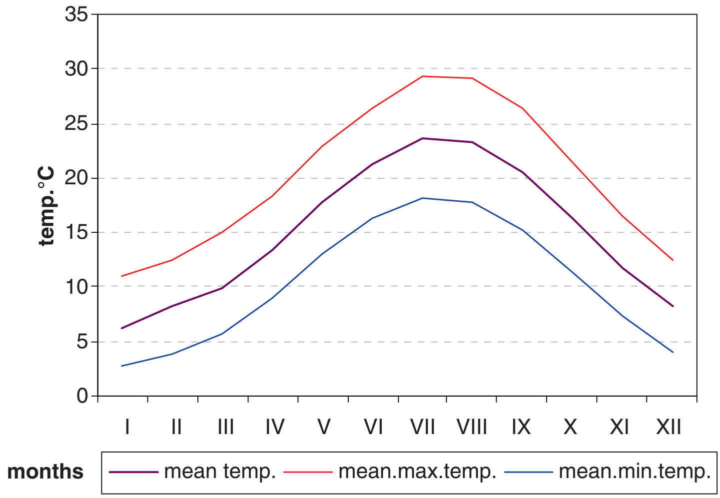


Figure 7. The annual course of temperature, low part.

The absolute minimal temperature is recorded in January at from −10.0°C to −14.7°C on the low and the hilly parts. The absolute maximum of around 41.0°C in July is almost the same in the two parts of the entire zone.

The analysis of the long term series of annual mean temperatures reveals that variation through the years does not present any statistically significant trend (slight decrease: 0.1°/10 years). Figure 8 shows the inter-annual course of the mean temperature anomaly (deviation from the long term average 1961–1990) for the lower part of the MRCA. It indicates only variability around the normal value with distinct periods of reverse trends. However, the last 15 years reflect an increasing trend as a consequence of an increase in both maximum and minimum daily temperatures, especially in summer (decrease of diurnal temperature in summer). The years after 2000 are characterized by a rise in the minimum temperature, higher than that of the maximum temperature in the summer.

5.2.1. Extremes in Air Temperature

Air temperature becomes adverse when it reaches extreme values (exceeds certain thresholds). The following analysis will focus on the maximum and minimum temperature regimes.

The maximum air temperature in this entire zone varies from 39.5°C to 40.0°C. To evaluate the regime of maximum temperatures, the number of days when the air temperature exceeds the threshold of 35°C is calculated

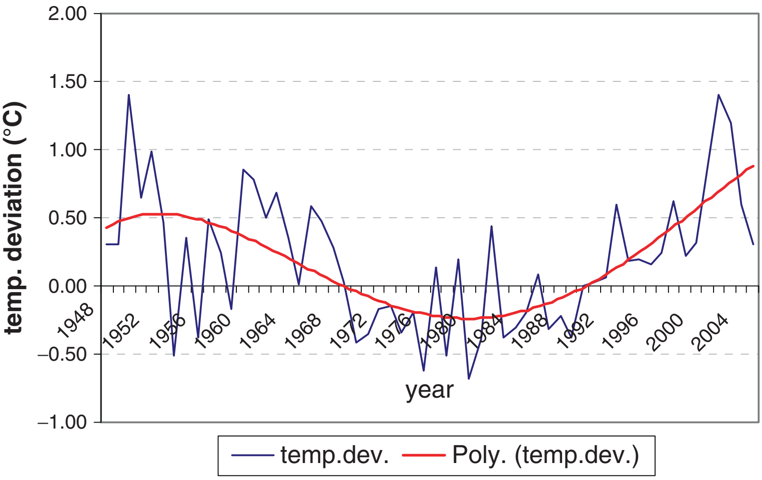


Figure 8. Inter-annual distribution of mean temperature anomaly (deviation from long term average 1961–1990) for MRCA, low part (period 1948–2005).

(Table 4). Temperatures over this threshold influence the quality of human life as well as agriculture and other branches of the economy.

Table 4 presents the absolute value of maximum and minimum temperatures for each decade and the number of days with maximum temperatures higher than 35°C (decade averages).

A thorough analysis shows that the highest values for both indicators belong to the lower part of the study area. As far as minimum temperatures, the absolute value varies from −10°C in the low part to −14.7°C in the hilly part. The number of days with minimum temperatures of ≤−5°C is very low in the lowland, contrary to the higher altitude where the number of days ≤−5°C is higher, up to 25.5 days/year.

5.3. PRECIPITATION

The total precipitation registered over the study area reaches up to 1,300 mm per year, varying from 1,360 mm/year in Lezha up to 1,470 mm/year on the hilly part (Rreshen). The highest value, about 66% of the total, is recorded during the cold months (October–March). The wettest months are November–December, while the driest are July–August (Figure 9).

Figure 9 illustrates the number of days with precipitation ≥1.0 mm which is one important indicator as well. The time and space distribution of these

TABLE 4. Average number of days with t > 35°C, absolute maximum and minimum temperatures.

Decade/years	1951–1960	1961–1970	1971–1980	1981–1990	1991–2000
Nr. days > 35°C	1.7	0.7	1.8	1.9	1.9
Max. abs. (°C)	37.5	38.3	40	37.5	40
Min. abs. (°C)		−10	−8	−6.7	−6.2

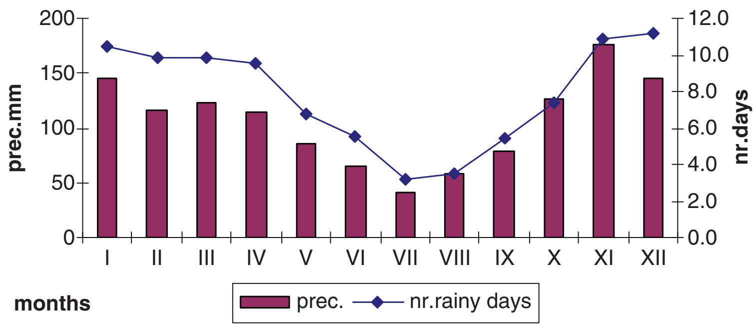


Figure 9. Distribution of precipitation total and the number of days with precipitation, low part (HMI).

rainy days generally follows that of precipitation. It reaches up to 94 days/year with the maximum value in winter (11.1 days in January) and the minimum in summer (3.2 days in July). There is no evidence of any considerable difference in the value of this indicator in the hilly part of the study area. So, on average there are about 96 days/year with precipitation ≥1.0 mm, with a minimum of 4.1 days in July and a maximum of 10.8 days in December.

Acknowledging the fact that there are no distinguishable differences in total precipitation between the two parts of the MRCA, the following analysis is focused on the low part of the area. The inter-annual course of precipitation anomaly (Figure 10) shows that the variation around the normal value up to the year 1980 is followed by a continuous decrease (total precipitation less than the long term normal value). The total precipitation remains under the normal value up to the year 2000. Thereafter it starts to increase over the normal value. There is clear evidence that the region is characterized by climate variability. Extreme events such as heavy rains, floods and drought are not rare phenomena for the area, and are part of this variability. But it is to be stressed that the vulnerability caused by these extreme events has more significant consequences in all systems than average changes in the climatic elements regime.

5.3.1. Heavy Rain

Heavy rain is considered a natural disaster when intensity or frequencies deviate very much from normal. This depends on the time interval duration and the level of the phenomenon.

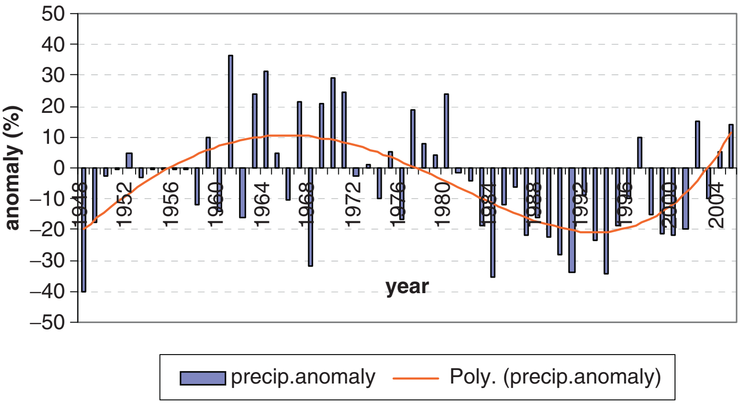


Figure 10. Inter-annual distribution of precipitation total anomaly (referring to long term average 1961–1990) for MRCA; low part (1948–2005).

In general, this catchment area is characterized by heavy rainfall, especially in the low part. This area suffers from very frequent flooding caused not only by heavy rain but also by poor management of the local infrastructure.

The long term course of daily maximum precipitation (24 h max) is given in Figure 11. Its value varied considerably from year to year during the period 1957–2006. Two years, 1970 and 2002, can be distinguished especially by the 24 h maximum precipitation of up to 220 mm.

5.3.2. *Snow*

Snowfall as one of the forms of precipitation is not a frequent phenomenon, even in the hilly part of the study area. It starts in November and stops at the end of March. Figure 12 illustrates the distribution of mean snow days during the year. The number of days with snowfall reaches low values, respectively 1.6–5.3 days/year, moving from the low part towards the interior.

The average maximum value of snow days in January is 1.8 and 0.5 days in the hilly and low parts respectively.

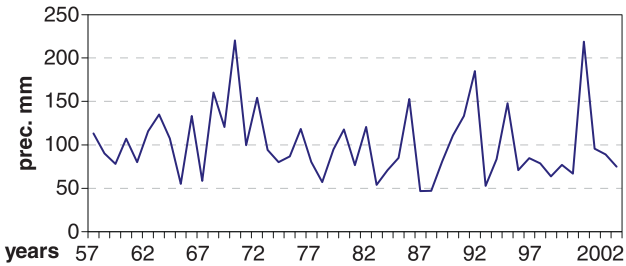


Figure 11. Annual distribution of 24 h of maximum precipitation, low part.

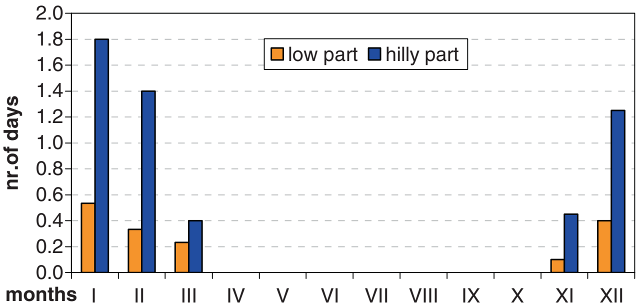


Figure 12. The annual course of number of snow days.

6. Current Climate Impact on Water Resources in the MRCA

The water flow regime (flood and dry periods) is strongly related to the type of river inflow which is mainly characterized by the climatic, physical and geographical conditions of the basin. But a very important factor, in most of the cases not quantified, is the human influence which makes it very difficult to complete an impact analysis. For that reason the current climate impact on water flow for the Mati River is focused on the Mati Shoshaj station, located above the hydropower cascade. Due to a lack of concurrent data the period 1960–1988 is considered.

The water flow of the Mati River has a seasonal and monthly variation. Its regime is characterized by two phases where the months from November to May belong to the wet phase and July to September belong to the dry phase (Figure 13).

The first phase is characterized by a flood regime as a direct result of precipitation and the second phase is characterized by a low rate of flow as a result of diminishing underground water resources. Precipitation as rainfall during this period has a minor impact on water flow for their local character and the losses in evaporation and infiltration.

The evaluation of the maximal discharge is very important as well, because it has a direct impact on the protection of all hydro-technology works that could be endangered due to the incorrect calculation of flood discharges. The maximum discharge is observed at the end of the fall and during the winter season, but sometimes even during other seasons. Figures 14 and 15 illustrate the distribution of precipitation (hydrologic year)[2] and

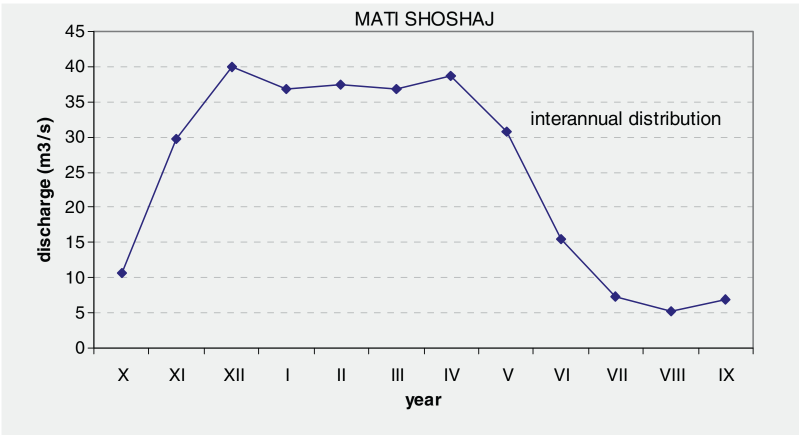


Figure 13. Inter-annual distribution of discharge, Station: Mati Shoshaj.

[2] This graph is only for illustration. Factors contributing to runoff include precipitation falling within the whole catchment area as well as the area's physical and geographical features.

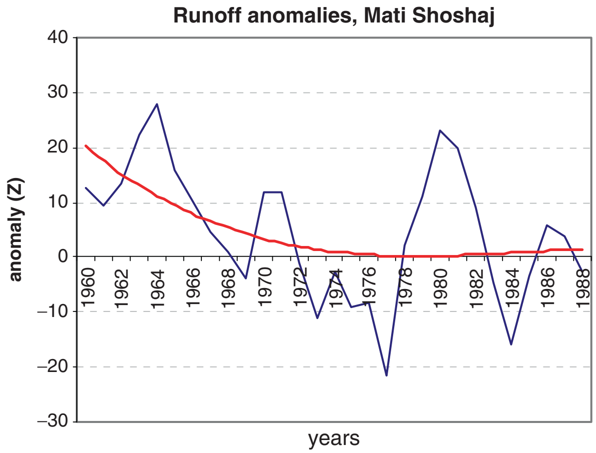


Figure 14. Distribution of runoff anomalies.

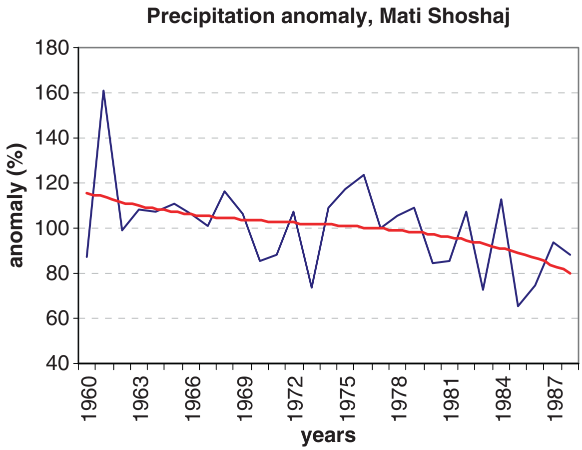


Figure 15. Distribution of precipitation anomalies, Mati Shoshaj.

runoff anomalies and their polynomial fit (second order) for Station Shoshaj. Both profiles show slight decreasing trends in recent years.

7. Current Impact of Climate Change on the Energy Sector

Climate variability and extremes have significant effects on the energy sector. High temperatures, changes in the precipitation regime, and variations in humidity, wind patterns, and the number of sunny days per year affect both consumption and production of energy.

7.1. CURRENT CLIMATE IMPACTS ON ENERGY CONSUMPTION

Climate affects the following major electric end uses:

1. Space heating
2. Air conditioning
3. Refrigeration and
4. Water heating

Out of these end uses, air conditioning and space heating are those significantly affected by climate variation, since both are functions of the indoor–outdoor temperature difference. The use of fossil fuels and firewood in households and public buildings (service sector) for space heating is the type of direct use of fossil fuels most affected by variations and extremes in climate.

Before the 1990s, dwellings were mainly heated with fuel wood. The fuel wood requirements of households, schools, hospitals and other public buildings were determined by the municipalities based on average heating volumes and appropriate degree days for each locality. Households were provided with vouchers entitling them to fuel-wood assignments. However, these were usually barely sufficient to heat the kitchen and, particularly during severe winters, had to be supplemented by private supplies collected unlawfully on a day to day basis. As a result, there is no sense in trying to find a correlation between the increase/decrease of the temperature due to climate change and the energy used for heating in the households or social-cultural dwellings.

Before the 1990s, the utilization of electrical energy for air conditioning in the household and service sector was insignificant for Albania. Air conditioning and ventilation was used only in big public buildings like theater halls, libraries, concert halls, and hospitals (surgery clinics), as well as in certain industrial sub-sectors like textile, paper, pharmaceuticals, etc. Because of the very small use of air conditioning/ventilation equipment at that time, their outdated technology, and lack of maintenance over the years, the contemporary impacts of climate on energy consumption due to cooling in Albania at that time could not be evaluated. Nowadays the situation has changed completely. In an increasing number of family homes, public buildings and private businesses, air-conditioning and ventilation equipment is penetrating very fast and the market is still unsaturated. For example, in 1999, the penetration rate of this equipment in households was only 4–5%.

The penetration rate of refrigerators in the household sector was less than 1% in 1960 (the full electrification of the country was completed in the late 1970s) and had increased to around 30% in the year 2000. Since we found a very low penetration rate and almost no data on the electrical energy consumed for refrigeration, it was not possible to establish a correlation between climate (temperature variation) and the energy consumed by refrigerators in the household sector.

A significant impact of climate on energy consumption is related to the preparation of domestic hot water. Heating water for washing clothes, showering and other sanitary purposes was unimportant during the period 1960–2000 in Albania. The use of wood for water heating was not a common practice except as a by-product for cooking or household heating. Water heating using kerosene was used increasingly in the 1980s but never attained widespread diffusion. Electric water heaters were not produced in Albania, where it has been more customary to use small electric coils submerged directly into the water vessel. In 1989 the average diffusion of electrical water heaters was less than 5% in urban areas and less than 1% in rural areas. Low penetration of water heaters for the mentioned period as well as the non-availability of data concerning energy consumption for water heating purposes did not allow us to assess the possible correlation between climate change and energy consumption for this activity. However changes in energy consumption are expected to lead to changes in energy production. The section below analyzes the current climate impacts on power generation with the focus on the MRCA.

7.2. CURRENT CLIMATE IMPACTS ON POWER GENERATION IN MRCA

Albania is heavily reliant on hydropower electricity production, representing a share of over 95% of the total. The total installed capacity of thermo power plants (TPPs) is only 224 MW; most of these are out of use because they are old, based on obsolete technology, and very poorly maintained. Almost 80% of TPPs have back-pressure turbines, and the rest, almost 50 MW, rely on cooling towers for the condensing process.

Thermal electric generation from fossil fuels could also be affected by climate. Higher ambient temperatures decrease the efficiency (the efficiency of a plant is a function of the ratio of the high and low temperatures in the power cycle) and capacity ratings of natural gas or oil fired combustion turbines. An increase in ambient temperatures and humidity is also detrimental to electricity generation on thermodynamic cycles, which rely on cooling towers for the condensing process. The overall effect of temperature increases on thermal electric power production proves to be small, however.

As a result, the correlation between changes in efficiency of our TPPs and the current climate regime is negligible.

The impact of climate on hydropower capacity is highly related to the impact on river flows. The impact of climate on river flows is very complex, but any significant changes in precipitation regimes have implications for hydroelectric generation. Climate change could affect the total and seasonal flow of most rivers, which in turn affects the amount of electricity produced annually by HPPs and the timing of power production, respectively. The mild winter of 2006/2007 with scarce precipitation demonstrated this effect fairly well.

An analysis of the impact of climate on hydropower generation in the MRCA takes into consideration two HPPs: Ulëza and Shkopeti. These two HPPs are the oldest in Albania and their capacity is maximally exploited.

Figure 16 shows the inter-annual course of electricity generation in Ulëza and Shkopet HPPs. The variation of energy production through the years might be explained by, among other factors, the variability of precipitation. So the decrease in production around the year 1990 is affected by a reduction in precipitation (see Figure 10). Clear evidence of flow impact is shown in Figure 17.

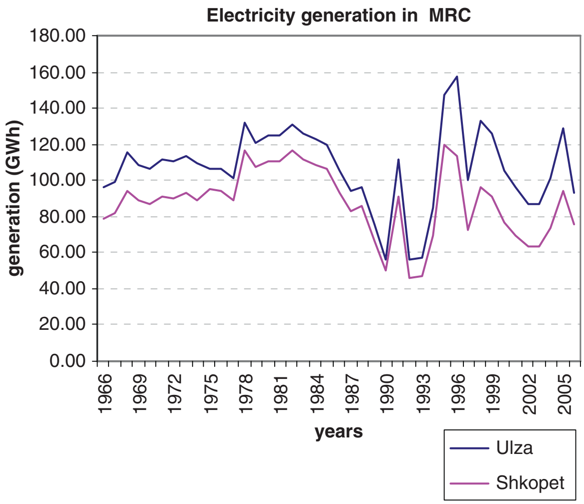


Figure 16. Electricity generation in MRCA.

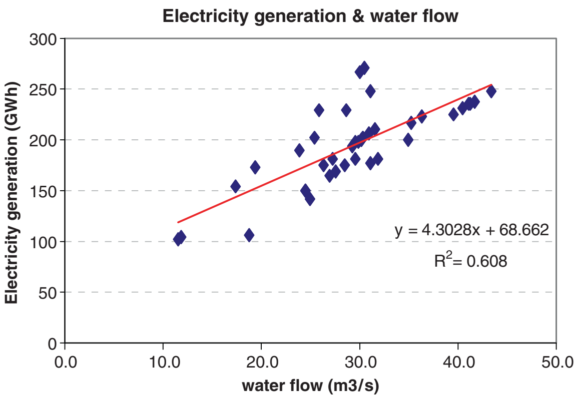


*Figure 17***.** Relation of electricity production to river flow, MRCA.

There exists a strong correlation ($r^2 = 0.61$) between electricity production and water flow, which on the other side is influenced by the climatic regime.

7.3. ESTABLISHING A POWER BASELINE

The Baseline Scenario for the power sector is developed in the framework of the NSE for Albania. As indicated in the methodological approach section, this scenario is developed with the assumption that Government measures under the Power Policy Statement for the short-term period (till 2010) are not rigorously applied according to the action plan. The time horizon for the scenario goes up to 2030. It indicates that the non-implementation of the necessary measures creates great difficulties and obstacles for the energy sector in general and the electricity sector in particular. This scenario provides a quantitative assessment of the existing power sector and the costs to fulfill policy goals, indicating the need for a rigorous implementation of the Power Sector Policy Statement, in order to avoid the total collapse of the power system.

The scenario assumes that most of the future demand for electricity will be fulfilled by the extension of thermal generating capacities (based on marine diesel fuel, light fuel oil, heavy fuel oil or imported natural gas) and the HPPs.

This scenario is built upon the assumption that, from 2010 onwards, there will be no net import or export of electricity. The electricity system is therefore balanced to meet requirements from the demand side underlying certain standards such as reserve margins, peak load, etc. Increased production of electricity may either be a result of new capacities, improved efficiencies or increased maximum capacity factors.

Figures 18 and 19 show electricity generated from power plants (existing and new ones), respectively in (GWh) and in (%), up to the year 2030. As per the baseline scenario the electricity produced by power plants located in the Mati River area will reach an approximate share of 5%. Figures 20 and 21 show the electricity generated up to the year 2030 where the shares of HPPs and TPPs are highlighted.

It is very important to highlight the fact that under this scenario the climate change impact on the Albanian power generation system is not considered.

According to the Baseline Scenario we can conclude the following:

- Electricity generation will increase from 5,850 GWh in 2000 to 14,000 GWh in 2030.
- The share between HPPs and TPPs will change in favor of TPPs. In 2000, 94% of electricity came from HPPs and only 6% from TPPs, while in 2030 the HPPs will contribute 6,500 GWh or 48% and TPPs 52% of the total.

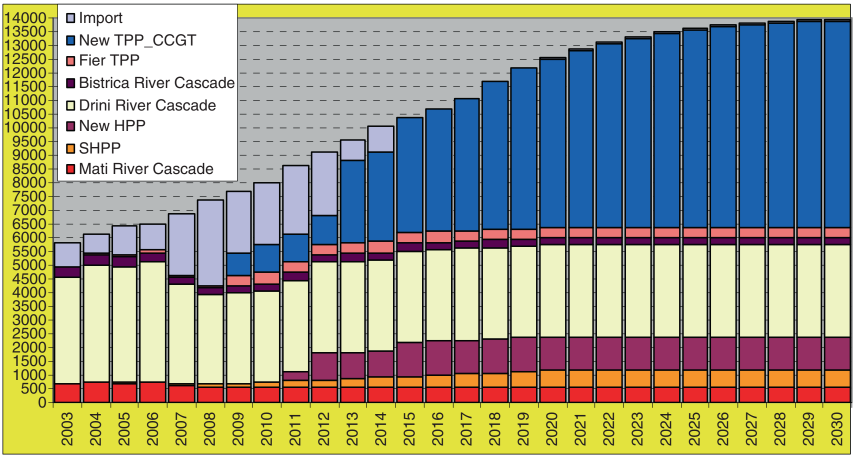


Figure 18. Electricity generation for each group. Baseline Scenario (GWh)

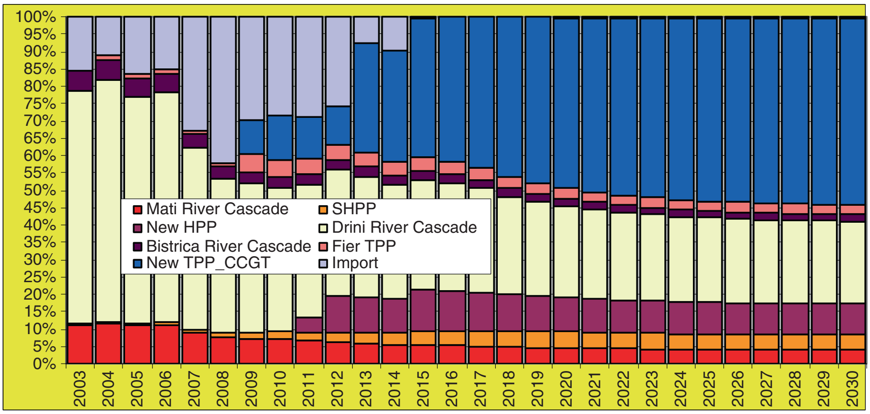


*Figure 19***.** Electricity generation for each group. Baseline Scenario (%)

The projected new capacities are based on recommendations provided by international institutions and consultants and adopted planning by KESH.

8. Expected Climate Change Impacts in MRCA

8.1. EXPECTED CLIMATE CHANGES

An increasing body of observations gives a collective picture of a warming world and other changes in the climate system.[3] Warming of the climate

[3] IPCC, 2001 The science of Climate Change

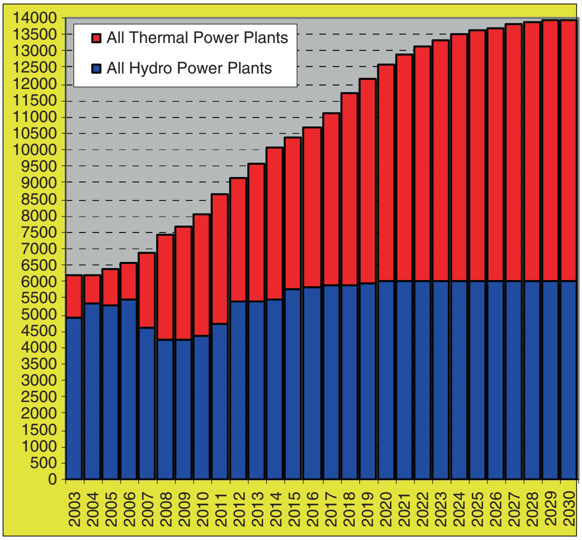


Figure 20. Electricity generation for Baseline Scenario (HPP and TPP) (GWh).

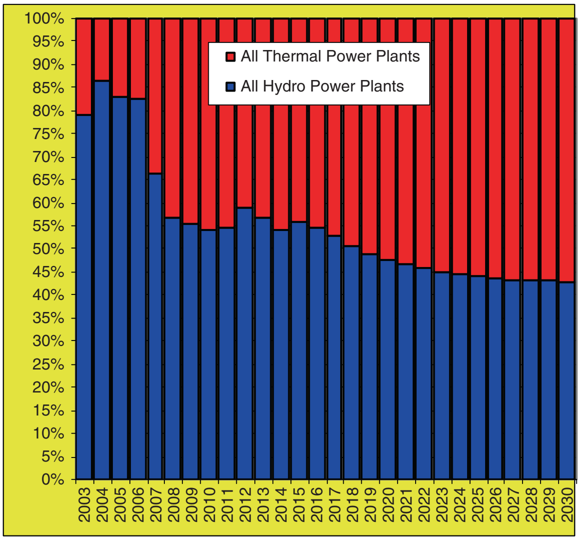


Figure 21. Electricity generation for Baseline Scenario (HPP and TPP) (%).

system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea levels[4]. The world's average surface temper-

[4] 4AR IPCC, 2007

ature has increased by around 0.74°C over the past 100 years (1906–2005). This figure is higher than the 2001, 100-year estimate report of 0.6°C due to the recent series of extremely warm years, with 11 of the last 12 years ranking among the 12 warmest years since modern records began around 1850. A warming of about 0.2°C is projected for each of the next 2 decades.[5]

Climate change will affect Albania through increased average temperatures and decreased precipitation. The expected annual and seasonal changes in temperature and precipitation estimated for Albania[6] are presented in Table 5 and Figure 25.

An analysis of the climate change scenarios for Albania (including those of MRCA) shows that an increase in temperature and decrease in precipitation are expected. So, we may expect milder winters, warmer springs, hotter and drier summers and drier autumns. It is important to emphasize that the outputs of the scenarios should be considered as indicators of changes that might occur and not as absolute values of changes.

By the year 2025 an average increase of 0.8°C is expected for winter and spring, about 0.9°C for autumn and 1.3°C for summer. A similar trend is expected by the years 2050 and 2100. An average increase in annual temperatures by 2.0°C (2050) and 4.0°C (2100) is expected respectively. A warmer summer by up to 2.8°C (2050) and 5.6°C (2100) might be expected (Figure 22). It is to be pointed out that the simulated results for 2030 are very close to those of 2025. So the annual average increase accounts for 1.2°C, those for winter and spring about 1°C. Temperatures for autumn and summer are expected to increase 1.1 and 1.6°C respectively (see Figure 25).

TABLE 5. Climate change scenarios for Albania.

Scenarios for Albania		Time horizon		
		2025	2050	2100
Annual	Temperature (°C)	0.8–1.1	1.7–2.3	2.9–5.3
	Precipitation (%)	−3.4 to −2.6	−6.9 to −5.3	−16.2 to −8.8
Winter	Temperature (°C)	0.7–0.9	1.5–1.9	2.4–4.5
	Precipitation (%)	−1.8 to −1.3	−3.6 to −2.8	−8.4 to −4.6
Spring	Temperature (°C)	0.7–0.9	1.4–1.8	2.3–4.2
	Precipitation (%)	−1.2 to −0.9	−2.5 to −1.9	−5.8 to −3.2
Summer	Temperature (°C)	1.2–1.5	2.4–3.1	4.0–7.3
	Precipitation (%)	−11.5 to −8.7	−23.2 to −17.8	−54.1 to −29.5
Autumn	Temperature (°C)	0.8–1.1	1.7–2.2	2.9–5.2
	Precipitation (%)	−3.0 to −2.3	−6.1 to −4.7	−14.2 to −7.7

[5] 4AR IPCC, 2007

[6] draft report of V&A, SNC

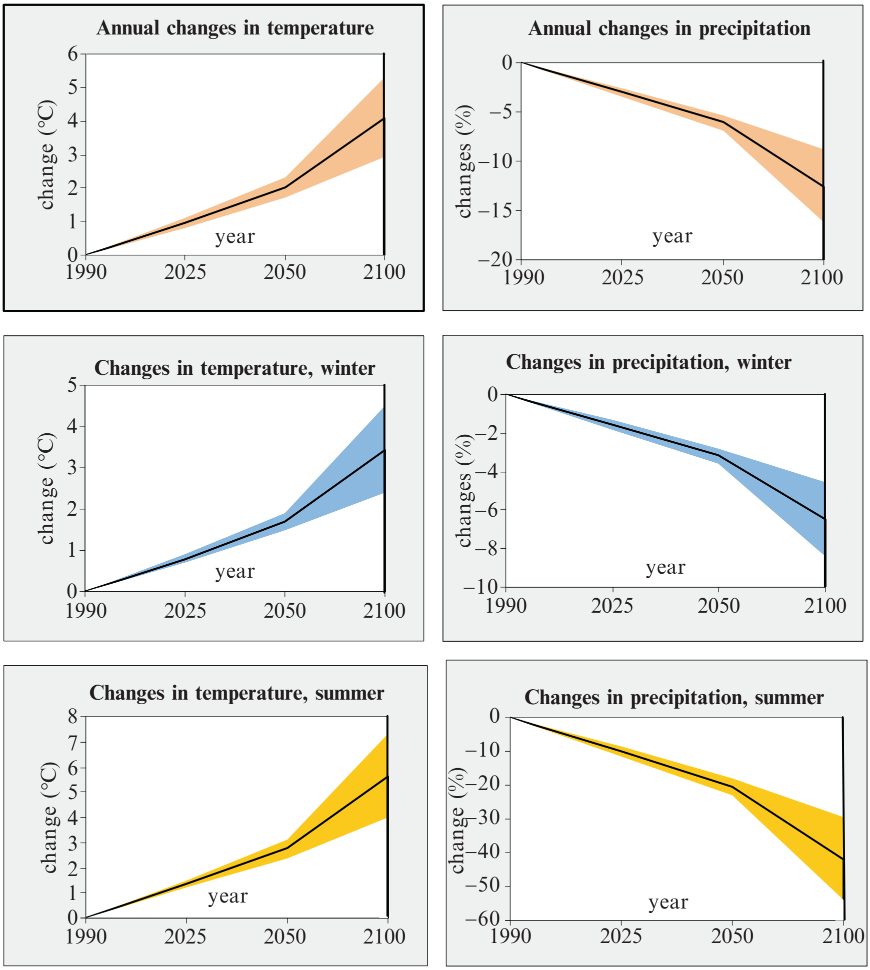


Figure 22. The expected changes in temperature and precipitation.

Regarding precipitation, the annual scenario leads to a decrease of annual value (average) of up to 3.0%, 6.1% and 12.4% for the 2025, 2050 and 2100 time horizons. A drastic decrease in total precipitation is likely to occur in summer. This average decrease is likely to reach up to 9.9%, 20.5% and 41.3% respectively. July is likely to contribute the most to this decrease (−19.6%, −23.5% and −49.7% respectively by 2025, 2050 and 2100). The same conclusions for temperature with simulated results for 2030 are very close to those of 2025, and valid for precipitation as well. So, by 2030, relating to the period 1961–90, annual precipitation is expected to decrease by up to 4.6%, and by about 2% and 12.2% in winter and summer respectively (Figure 22).

These likely changes in the regime of temperature and precipitation are expected to lead to a cascade of changes in other climatic parameters. So, there is projected to be a general drying over the study area during summer. This is ascribed to a combination of the increased temperatures (likely increase up to 5.6°C) and potential evaporation that is not balanced by precipitation (reduced by around 41%).

Recent investigations show that increasing temperatures will be followed by an increase of probabilities for extreme events and a higher intra-annual variability of minimum temperatures.[7] Increases more in daily minimum than maximum temperatures are likely to occur over the study area. More frequent and severe droughts with greater fire risk are likely.

A decrease in the number of freezing days (temperatures ≤−5°C) in high altitudes is likely to occur, accounting for a decrease of about 4–5 days, 9 days and 15 days respectively by 2025, 2050 and 2100. It is obvious that in the lowlands, especially in the Lezha area, the value of this indicator is very low (less than 1 day/year), contrary to that in high altitudes where the number of days <−5°C is higher, up to 25.5 days/year.

It is to be pointed out that with expected higher average temperatures in winter, more precipitation is likely to fall in the form of rain rather than snow, which will increase both soil moisture and run-off. It is to be mentioned that increases in the total precipitation rate may induce greater risks of soil erosion, depending on the intensity of rain episodes.

The extreme high increase in summer temperatures is likely to result in increases in the frequency or intensity of extreme weather events (heat waves). It is known that the relationship between averages and extremes is often non-linear. For example, a shift in average temperature is likely to be associated with much more significant changes on very hot days. It will have drastic consequences on all socioeconomic systems, especially on energy production.

The analysis shows the number of days with the temperature ≥35°C is likely to increase from 1951–2000 averages by about 1–2 days by 2025, and about 3–4 days by 2050. There is also an expected increase in value for this indicator by 2100 (about 5–6 days over the mountainous part, and up to 8 days on the lowland areas).

Although total precipitation is expected to decrease, an increase of intensive rain episodes is likely. So, we can expect an increase in the number of hazardous rainy days of about 1–2 days by 2025 as compared to 1951–2000, of about 2–3 days by 2050, and of about 3–5 days by 2100. This is likely to have great consequences, especially on agriculture.

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[7] IPCC, 1997

8.2. EXPECTED CLIMATE CHANGE IMPACTS ON RIVER FLOW OF THE MRCA

Generally, higher temperatures lead to a higher potential for evaporation and decreased discharge (which also is a function of precipitation, storage, and topography). The storage of water in the soil serves as a buffer in winter and spring. Increasing precipitation normally generates higher discharge because the buffer is full and evaporation is low. During the summer, storage is reduced by evapotranspiration and must be refilled before discharge begins. Because of many complex interactions between these factors in time and in space, changes in the hydrological cycle are more difficult to model and to analyze than temperature and precipitation data.[8]

The most important climate change effect within this basin is a change in the timing of stream flow throughout the year. As mentioned, snowfall is not a frequent phenomenon, even in the mountainous part of the study area. Increased temperatures mean that this phenomenon is expected to be even rarer. So, there is proportionately more runoff in winter, less snow to melt and less runoff during spring. Increased temperatures, in effect, lead to an increase of evapotraspiration reducing the size of the reservoirs storing water during winter.

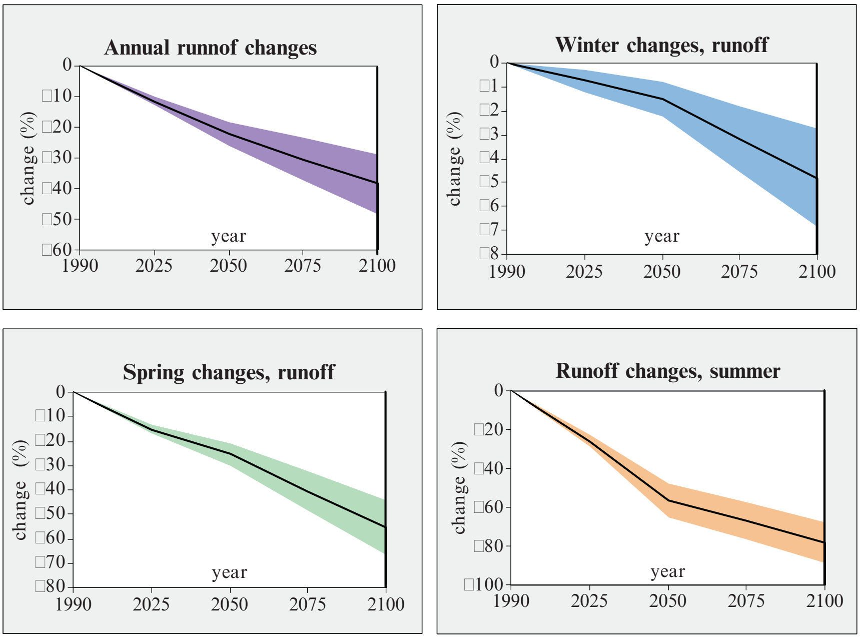

Figure 23. Expected changes in runoff, Mati catchment area.

[8] IPCC, 1997

To evaluate the effects of Climate Change on the Mati Basin, a hydrological rainfall – runoff model was applied.[9] The precipitation and temperature input into the model was spatially averaged over the basin using the Thisean method for precipitation and arithmetic mean for temperature. The model was calibrated with data for the standard period 1961–2000.

Figure 23 presents the likely changes in runoff as a result of expected changes in the temperature and precipitation regime. Comparing the results of the changes obtained in river runoff, it can be stated that an increase of the long term mean annual and seasonal air temperature and a decrease of mean annual and seasonal precipitation (combined with higher evaporative demand) would probably result in less river flow.

Therefore, a decrease in the long term mean annual and seasonal runoff is expected for the water basin. In general, the decrease in discharges can be expected for all the time horizons with an accelerated decrease towards 2100. Even within each time horizon there are oscillations because they express the change of runoff as a result of the different extreme possibilities of climate change.

A more detailed analysis shows that there are no significant changes for the winter for all time horizons. Runoff is expected to reduce by a maximum of 7% by 2100. The floods will still occur during this season and for the reasons we mention above even the spring floods will shift toward the winter.

As contributors to hydrological systems, snow and ice and their potential changes in the warmer global climate will have a profound impact on streams and rivers. Higher temperatures will shift the snowline upwards; the seasonal patterns of snowfall are likely to change with the snow season beginning later and ending earlier. So, the spring runoff is expected to be significantly reduced. The maximum reduction amounts to 30% and 66% respectively by 2050 and 2100. The hydropower industry must take into consideration the expected runoff reduction in electricity generation because Albania is dependent on hydropower.

In the Mati River Basin the minimum discharge occurs during the summer (August) and the low-flow frequency will increase across most of the catchment area. The season of lowest flow will still be the summer. During summer we may expect the highest decrease as compared to the other seasons, because of the likely change of climate.

8.3. ASSESSMENT OF THE IMPACTS OF EXPECTED CLIMATE CHANGES ON THE POWER SECTOR

Climate change is likely to affect the major electric end uses such as space heating, air conditioning, water heating and refrigeration. Warmer winters

[9] draft report of V&A, Second National Communication

would reduce "heating degree days" and the demand for heating energy. On the other hand, the increases in air temperature are also projected to lead to increases in the "cooling degree days". Such a tendency would enhance the urban heat island effect and thereby heat stress. Increased demand for water irrigation would also augment the demand for energy.

Changes in energy consumption as a result of likely climate change will lead to changes in energy production. The likely runoff reduction is expected to have a significant influence in electricity generation in Albania. A likely reduction of 20% in natural water runoff was projected to cause a reduction in power generation of 60%, whereas a 20% increase was projected to cause an increase in generation of 40% (Bruci et al., 2002).

There is a projection for general warming and reduction in precipitation over the study area. It will result in less electricity being produced by the hydropower dams year-round. A reduction in hydropower generation would have to be made up by more thermal electric generation. Thus, a heavy reliance on hydropower may be good for reducing GHG emissions and improving air quality in Albania, but can increase vulnerability to climate change.

Expected changes in solar radiation and wind speed may also affect the supply of energy from solar and wind power. So, a likely decrease in total cloud cover will lead to an increase in global solar radiation and hours of sunshine. This will promote the use of solar energy for different energy services.

Based on the outputs of the climate change scenarios and impact on the mentioned water resources, the energy scenarios that consider climate change effects are developed with special emphasis on the HPPs located in the MRCA.

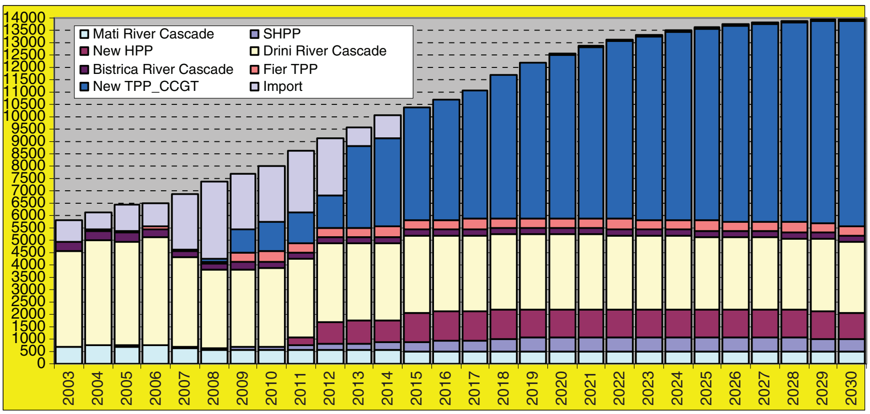

Figure 24. Electricity generation for Alternative Scenario (GWh).

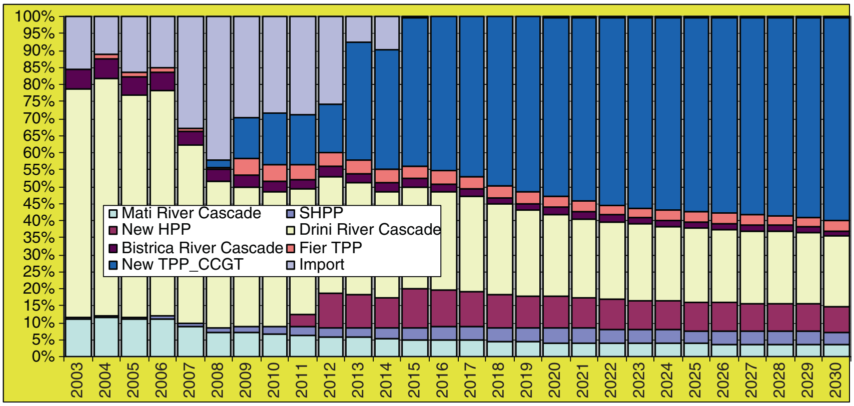

Figure 25. Electricity generation for Alternative Scenario (%).

8.3.1. Energy Scenario That Considers Climate Change Impacts (Supply Side)

Referring to the Power Baseline Scenario, an alternative scenario which considers climate change impacts has been developed. A recalculation of the electricity demand has been conducted for all sectors: residential, service, industry, and agriculture, also taking into account the transmission and distribution losses of the Albanian power network.

The energy demand for space heating takes into consideration changes in heating degree days. Those changes are reflected in the decrease of energy intensity for dwelling space heating demand as the result of increasing average temperatures for the whole region. Total projected electricity demand for space heating is included in the alternative scenario, which is shown in Figures 24 and 25. The contribution of HPPs located in the MRCA is likely to decline from 660 GWh/year by 2030 to 480 GWh/year due to climate change impact.

The energy demand for space cooling (electricity demand for the residential and service sectors) is likely to increase. As a result of increasing average temperatures for the whole region the number of cooling degree days is expected to increase. Total forecasted electricity demand for space cooling is included in the alternative scenario, which is shown in Figures 26 and 27.

Taking into account the mean annual change in the river's water flow and the simulated outputs for 2030 (Table 6, Figures 22 and 23), the new Energy Alternative Scenario, which considers climate change impacts for the period 2000–2030 (Supply Side) has been developed (Figures 24 and 25). According to this scenario, the HPPs located in the MRCA generated 660 GWh in 2000 and will generate 560 GWh in 2030. Electricity generation (GWh) up to the year 2030 divided among generation plants (existing and planned) is given in Figures 26–29.

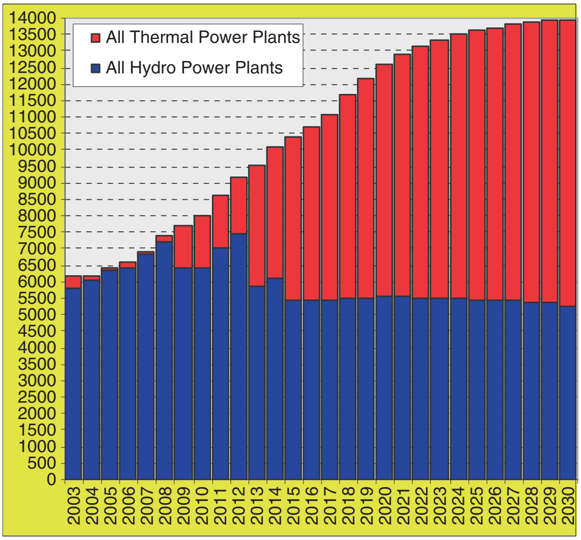

Figure 26. Electricity generation for Alternative Scenario (HPP and TPP) (GWh).

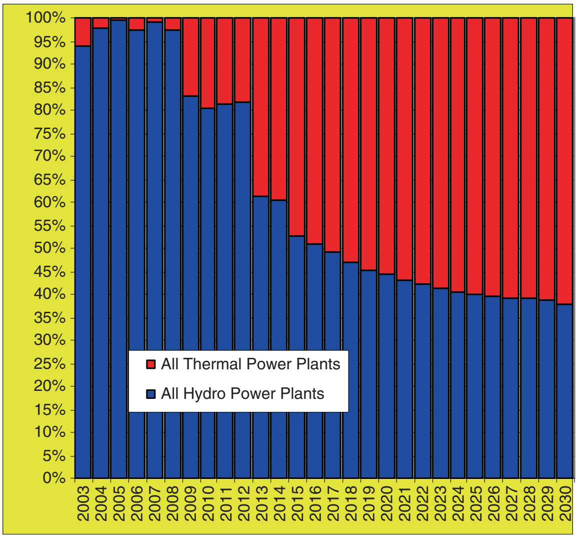

Figure 27. Electricity generation for Alternative Scenario (HPP and TPP) (%).

Figures 28 and 29 describe the electricity generated up to the year 2030, including the share between HPPs and TPPs. From the figures above we can conclude the following:

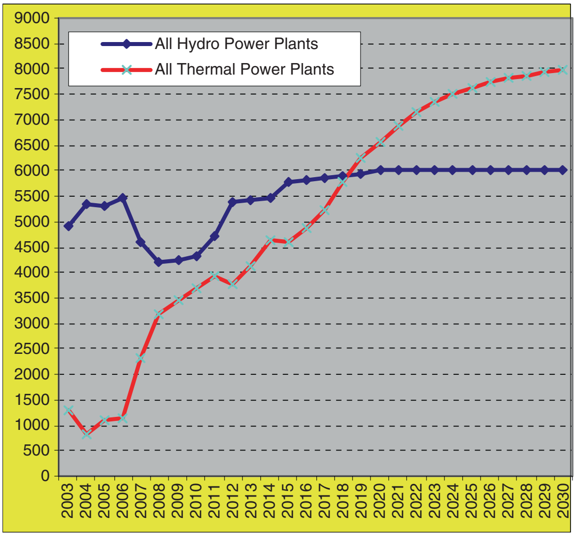

Figure 28. Electricity generation for Baseline Scenario (HPP and TPP) (GWh).

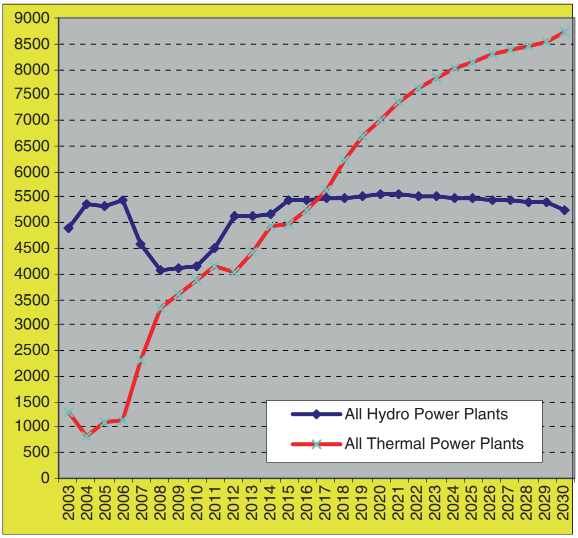

Figure 29. Electricity generation for Alternative Scenario (HPP and TPP) (GWh).

- Electricity generation will increase from 5,850 GWh in 2000 up to 14,000 GWh in 2030[10] (Figures 26–29); the impact of climate change likely will cause a reduction of 660 GWh (Year 2030) or 10–12% of total

[10] This is the same with the old scenario, since the changes in the river's water flow are reflected only in the share of electricity supplied by Hydro and Thermal Power Plants

hydro generation in 2030. In order to meet demand, the capacity of TPPs needs to be increased up to 700 GWh, the equivalent of 120 MW.

- The share between HPPs and TPPs will increase in favor of the latter. Unlike the electricity generated in the year 2000 (94% from HPPs, 6% from TPP), in 2030 HPPs will contribute 5,250 GWh or 41% and TPPs will contribute 8,709 GWh or 59% of the total.

The scenarios developed show that TPPs will cover the largest share of electricity generated in 2030. They will even compensate for the portion of electricity not produced by HPPs due to climate change impacts. This is a very important conclusion to be considered by energy decision makers in preparing strategic plans for the development of the power sector in the future. The estimated cost of meeting this demand is €13–60 million (for the years 2008–2030).

9. Adaptation Measures in the Power Sector in the MRCA

This is the first time that Albania will be attempting to include the impacts of climate change as an integral part of its sustainable development programming in the Albanian Power Sector.

The above mentioned analysis shows that it is very important to set up a list of measures to meet electricity demand for the future by considering likely climate change effects as well as other factors. As mentioned in the methodology section, a list of adaptation measures has been developed and prioritized according to their importance through application of multi-criteria analysis. The proposed measures are focused on the selected priority system – that of the MRCA – by taking into consideration the scenarios (climate and power) analyzed in the previous sections.

The **adaptation measures** in order of priority are as follows:

1. Build new and very efficient TPPs (combined cycle) in order to fill the remaining gap in power supply.
2. Maximize the share of HPPs in the face of climate change impacts through the rehabilitation of Ulëza HPP and Shkopet HPP (located in the MRCA).
3. Maximize the share of HPPs in the face of climate change impacts through the construction of small HPPs.[11]

[11] Most small HPPs will be run-out-of-river type that will be impacted much more than medium and big HPPs with reservoirs.

4. Integrate climate change impact into regional development programmes, plans and policies[12] in the MRCA.
5. Maximize the share of HPPs in the face of climate change impacts through the construction of new, medium and big HPPs taking climate impact into consideration.
6. Build capacities at the community level within the MRCA to monitor and respond to anticipated climate change impacts on power generation.

10. Conclusions and Further Considerations

Climate change is affecting Albania's hydropower sector due to severe impacts of climate change on water resources. Albania is currently putting together a long term investment plan (to 2020) for the energy sector, with a particular focus on hydro power generation which covers a share of over 90% of the whole country's generation capacity. At the same time there is growing concern about sustaining hydropower generation due to climate variability and future change. The latest vulnerability studies suggest a current variation of total runoff formation which will further decrease by 25% by mid century.

The government of Albania has not been considering climate change impact and risks in its long term energy sector investment plan. The study focused on the MRCA shows that there is a significant need to support well informed decision making for long term development planning by sensitizing the investment scheme to climate change risks. This can be done by developing and considering the findings from alternative scenarios which include a combination of alternative options such as maximizing the share of hydro power potential in the face of current and future vulnerabilities and filling the remaining gap through other alternative sources of energy based on the assessment of those sources.

There is a significant need for pilot projects aimed at the implementation of the measures identified in such a study after their refinement and an in-depth review. This might be done through an intervention enabled through a project aiming to raise awareness and support decision makers in the power sector to address climate impact and risk in the planning process for the power sector. The project will help execute the most viable investment options for sustainable energy sector development in Albania in the face

[12] As described in the baseline section, there are several projects and programmes underway in the MRCA for promoting sustainable development of the region.

of climate change. The project will have both short/medium and long term implications on the development agenda of the country, including poverty reduction (by improved access to rural energy and improved environmental management).

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SMALL HYDROPOWER RESOURCES AND PROSPECTS OF SMALL HYDROPOWER ELECTRIC PLANTS IN THE NEAR-BORDER REGIONS OF UKRAINE

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Abstract: Small hydropower plants (SHPs) are well-known as comparatively safe and stable sources of renewable electric energy. SHPs can be installed in many rivers including those which are rather small and unsuitable for standard hydropower plants.

Very rich large and small water sources can be found near the border region of Ukraine. These can be used effectively to substitute traditional and even unsafe renewable energy plants and enhance Ukraine's energy security level. The prospective energy potential of Ukraine's small hydropower plants is assessed at 2,500 million kW-hour while its current utilization is only about 170 million kW-h. It is vitally needed to pay more attention and to attract more investment into this field to reach appropriate levels of sustainable hydropower energy production and energy security for the near-border regions of Ukraine and the entire country.

Keywords: Energy security, sustainable energy production, Small hydropower plants

1. Introduction

1.1. ENERGY AND SECURITY

Everything in modern society runs around energy. Low energy production can seriously slow down the economic development of any country and threaten its security. The price of energy is one of the basic factors in total price. Energy exporting countries can even try to use energy as a tool in their foreign policy, which has been clearly seen in the Russian Federation's attempts to influence various decisions through the export price of Russia's natural gas.

That is why an "energy" component becomes more and more important in the entire security of any country. The more energy that can be supplied from one's own resources, the more "energy" independent a country is.

Countries conduct various energy policies. Some countries pay more attention to traditional energy sources. Among these, some countries receive most of their electrical energy from thermoelectric power plants, some countries from nuclear power plants and there are some countries with leading energy production from hydropower plants (see Table 1).

It is seen that nuclear energy production is the leading field in France and thermoelectric energy production is still the leading field in many other countries. It is interesting that Norway, which possesses rich deposits of natural gas and oil, produces most of its electric energy from its own renewable resources – from hydropower plants. Norway reaches the highest per capita rate of electricity production. About two thirds of the heating system is fed by its own electricity. This way, Norway eliminates waste gas emissions from traditional heating systems and keeps very good urban environmental conditions.

Increased power production at thermal and nuclear power plants requires lower investment and is easier technologically as compared to increasing hydropower production. Indeed, the latter option would require massive and very expensive construction work related to reservoir and dam building. On the other hand, there are some social and technological problems discussed below that can cut the prospects of raising thermal and nuclear power production.

Hydropower plants are free from these obstacles. SHPs with an installed power capacity under 10 MW do not even require the construction of high dams and wide reservoirs flooding wide land areas. This fact opens wide

TABLE 1. Energy production from various power plants.

Country	Thermoelectric energy percentage	Nuclear energy percentage	Hydropower energy percentage	Other sources (solar, wind, etc.)
U.S.A.	68.5	19.6	9.6	2.3
China	81.,3	1.3	17.4	–
Japan	59.4	30.2	8	2.4
Russia	68.2	12.8	18.9	–
France	8.4	78.2	12.8	0.6
Norway	1.1	–	98.1	0.7
Ukraine	41.4	52.1	6.5	–

All data relate to the average annual energy production in 1999–2005.

prospects for sustainable power production at SHPs especially in river-rich hilly areas without big industrial facilities.

2. Energy Production and Energy Security in Ukraine

Power production currently exceeds power consumption in Ukraine and some Ukrainian electricity is exported. The average annual energy export from Ukraine was rated at about 10 billion KW-h in 2006. Ukrainian electricity is exported to almost all neighboring countries: Poland, Hungary, Russia, Slovakia, Romania, Moldova and Belarus. Based on this fact one can classify Ukraine as an advanced and secure country with respect to energy.

However, this conclusion appears doubtful once taking into account the structure and background of energy production in Ukraine.

As seen from Table 1, Ukraine produces almost equal parts of electricity from thermoelectric and nuclear power plants. Even though local thermoelectric power plants work using mostly local Ukrainian coal, this energy source would not be able to meet the growing economy's needs because of the following:

- Thermoelectric energy is rather ecologically unsafe and its increased production would cause extended emission of waste gases and solid wastes.
- The Kyoto Protocol limits carbon dioxide emissions, which are emitted mostly by thermoelectric power plants (Ukraine has not reached its Kyoto limits; however, it is close to this value).
- Coal deposits in Ukraine are found in deeper layers and require extended mine work, which is quite expensive and very unsafe.
- Even rich coal deposits will be used up causing a reduction of thermoelectric energy production and a rise in price.

Proceeding from these limitations we can not consider thermoelectric power plants as a secure source of energy for the growing economy.

There are four nuclear power plants in Ukraine, which produce more than half of its electrical energy. Ukraine has rich deposits of uranium ores; however, the complete technological cycle of nuclear fuel production and nuclear waste treatment includes some operations held abroad (in the Russian Federation). Therefore, this energy source also cannot be considered as completely secure. Moreover, increasing the capacity of nuclear power plants would definitely meet strong social resistance, which is not going to diminish after the disastrous Chernobyl catastrophe.

As a result, one can see that only hydropower energy plants can ensure needed energy production without serious environmental and social problems.

However, traditional hydropower plants cause some serious environmental problems. First of all, one can mention the flooding of wide land areas and unfavorable changes in the water wildlife caused by the formation of artificial reservoirs and lowering of the water circulation coefficient.

3. Hydropower Energy Production in Ukraine: Current State and Prospects

There are more than 40 working hydropower plants in Ukraine. They are located mostly on the main rivers: Dnipro, Dnister, Southern Bug and Tisza. The construction of any hydropower plant causes flooding of agricultural and rural areas and numerous resettlements. On the other hand, the significant water resource contained in the artificial reservoirs has become very useful for the water supply systems of neighboring agricultural and industrial developments mostly located in the southern and eastern part of Ukraine (Winkler and Tevtul, 2006).

The history of SHPs started years ago simultaneously with traditional plants. Ukraine is very rich in small rivers that are not suitable for traditional hydropower plants but for which SHPs can effectively use the river flow. There were 956 SHPs in Ukraine in the 1950s. Some SHPs worked with natural waterfalls and river rapids, i.e. they were not connected with artificial reservoirs. For example, such a plant worked at the waterfall near the settlement Krasne (Ternopil region) until the 1970s and supplied electricity to three neighboring towns (Tsymbalenko and Vikhorev, 2005).

However, interest towards SHPS diminished as new traditional hydro and nuclear power plants were placed into operation and less than 50 SHPs were still active in Ukraine by the 1980s.

The idea of small hydropower generation received new interest only at the beginning of the 21st century and about 70 SHPs were in service in 2006.

First of all, new interest towards SHPs arose because of widening energy shortages and the rising price of energy production and transportation. Energy production at small power stations next to settlements or small industrial facilities is sometimes more profitable than energy production at big stations and distribution to numerous remote customers. Construction and maintenance of SHPs do not require much funding and investments can be completely repaid within 5–8 years. On the other hand, the equipment and technologies used in SHPs is well known, quite safe, effective and reliable. In other words, this type of energy generating facility does not require an extensive investigation and equipment trial period and can be installed and placed into operation rather quickly.

It is important to note that we cannot expect SHPs to be a substitute for traditional hydropower plants, especially those supplying inexpensive energy for big industrial facilities. However, municipal electricity consumption takes about 20% of the total energy consumption in Ukraine [http://mpe.kmu.gov.ua/fuel/control/uk/publish/article?art_id=107478&cat_id=35086] and this sector of the energy production and consumption is very attractive for SHPs.

4. Small Hydropower Plants in EU and Ukraine: Present and Future

Energy production at SHPs is well developed in many EU and EU candidate countries (see Table 2) (Tsymbalenko and Vikhorev, 2005).

As seen from Table 2 (Part 1), the Czech Republic operates the highest number of SHPs, which produce one third of the total hydropower production or 1% of overall national energy production. SHPs represent 100% of the hydropower energy production of Estonia. This is easy to understand because this country is mostly flat and there are no relief conditions to construct a traditional hydropower plant with a reservoir.

The highest proportion of SHP energy production is reached in Slovenia, where over 400 plants produce more than 2% of the overall national energy production.

Even though energy production at SHPs may seem insignificant for an entire country, this kind of power engineering can be interesting and pro-

TABLE 2. Energy production from SHPs in some EU and EU candidate countries.

Country	Quantity of SHPs	Total power, MW	% of Total hydro-power production	% of Total power production
Part 1 (small countries)				
Czech Republic	1,136	250	33	1.0
Estonia	13	3	100	0.2
Slovenia	413	77	8	2.3
Hungary	35	9	25	0.1
Bulgaria	64	141	22	1.0
Romania	9	44	1.8	0.6
Turkey	67	138	1.7	0.5
Part 2 (Large countries)				
Germany	6,200	1,500	17	1.3
France	1,730	2,000	8	1.8
Austria	1,700	866	8	5
Italy	1,510	2,230	11	3
Spain	1,106	1,607	9	3
Denmark	40	11	100	0.1
Netherlands	3	2	2	0.01

spective for certain regions of any country. For instance, hilly and lowly populated areas without large industrial facilities still require energy supply. Construction of a traditional power (or hydropower plant) in such a region is inexpedient and long distance energy transportation leads to increased expense. Therefore, an SHP can be a reasonable alternative power source for such regions. That is why hilly Slovenia, Turkey and the Czech Republic (compared to, e.g., Hungary) are leaders in SHP energy production.

Some larger EU countries pay a great deal of attention to the development of SHPs. Thousands of SHPs operate in Germany, France, Austria and Italy producing rather significant amounts of total hydropower energy. This kind of energy engineering has a long historical tradition in these countries where the first SHPs were installed at the beginning of the 20th century.

There are many regions of Ukraine that seem suitable for the construction and operation of SHPs, especially near the western border and in the Carpathian region. Table 3 presents the current state of energy production from SHPs in some regions of Ukraine and the projected energy production through the renovation of SHPs previously operated but no longer in use. As seen from Table 3 (right column) the Western regions of Ukraine are very rich in small river hydropower potential (especially Transcarpathia). These regions are mostly hilly and less populated as compared to the Eastern part of the country and there are no large industrial energy consuming complexes in the Western part. That is why SHPs seem very attractive for this part of

TABLE 3. Energy production at SHPs in some regions of Ukraine (bold values represent Western border and Carpathian regions of Ukraine).

Region	Current state		Prospective state		Expedient hydropower production potential, million kW-h
	Q-ty of SHP	Power, MW	Q-ty of SHP	Power, MW	
Vinnitsa	12	21	17	18	108
Donetsk		–	–	–	57
Transcarpathian	3	32	4	1	1357
Ivano-Frankivsk	1	2.5	–	–	120
Chernivtsi	–	–	5	1.3	265
Volyn’	–	–	–	–	35
Mykolayiv	4	12	–	–	47
Odessa	–	–	1	0.8	11

Ukraine. As seen from Table 3, some old and currently disused plants can be returned back to operation in the Transcarpathian and Chernivtsi regions. These projects would not require significant funds, as would be needed for the construction of new plants. The plants already operating and renewed should demonstrate the effectiveness of this type of energy production and attract more attention and investments into this field.

It is important to emphasize that SHP energy production is one of the fastest and most practical kinds of modern sustainable energy production; however, it vitally requires proper legislation to promote its development. We suppose that electrical energy purchase and distribution tariffs should be differentiated for various hydropower plants. This differentiation should take into account the SHPs' much lower negative impact on the environment as compared to standard hydropower plants, which require major environmental protection measures. Lower purchase tariffs for sustainable hydropower electricity would add a competitive advantage into this field and promote its faster development to achieve the more effective use of the small rivers' hydropower potential.

5. Conclusion

5.1. WHY SO MUCH ATTENTION TO SUCH AN "UNIMPORTANT" ENERGY RESOURCE?

The European Commission recommends reaching up to 12% of energy production from renewable resources in 2010. Hydropower plants can be classified as renewable energy resources but they still bring some negative environment effects.

On the other hand, hydropower energy production still encounters some incorrect myths – for example, that it is an outmoded branch of energy production connected to very large construction and operating costs. Small hydropower energy production is sometimes considered as a very expensive and exotic type of energy production which is good for experimental samples but can hardly be used in regular operation.

That is why we propose that SHP should be correctly positioned as an alternative power source for *some* regions, which do not intend to completely substitute traditional hydropower plants or, moreover, other energy sources. Reasonable tariff policies would add more interest to the renovation of old and the construction of new SHPs in hilly regions with numerous small rivers. Even a small substitution of organic fuel usage in energy production still brings positive environmental effects.

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THE RISKS OF USING RENEWABLE ENERGIES

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Abstract: The use of fossil fuels, which supply the needs of modern humanity, pollutes our atmosphere with more and more CO_2, speeding up the greenhouse effect, heating the Earth and generating global changes in our climate. The consequences of this are not known, although we have been given a few scenarios about our future, from the rising of the level of oceans to a new ice age. If the average temperature continuously rises, then the icecaps will melt and the level of the oceans will rise. As 60% of humanity lives on or near the coast, this will cause serious problems. According to another theory, the enormous mass of freshwater from ice melt will attenuate the salt water of the Gulf Stream and interrupt its flow, which can cause a new ice age in Europe. Anyway, what is sure is that we have started an irreversible process, we must be aware of its consequences and, if possible, we must try to stall it. One possible way to do so is to lower our CO_2 emissions, for example, through the use of renewable energies. Sources of renewable energy include wind, solar and hydro energy and biomass. Using these sources of energy, we can lessen our greenhouse gas emissions. But, of course, this has two sides. Using renewable energy presents plenty of dangers. I try to focus my attention on these dangers in my study. For the use of hydropower we must build dams and aquifers, which can influence another country's water supply, thereby potentially causing conflicts. The use of biomass can also be dangerous. First of all, the mass of green stock can displace food crops and can cause starvation; the cutting and parching of the Brazilian rainforest for growing green stock will have more environmental consequences. These are only two of the problems, dangers and challenges I explain in my study.

…economy is already late, when the wealth is running out

Seneca

1. The Theory of Climate Change

The climate is the most complex process on our planet. Without the greenhouse effect there would not be any life on Earth. The atmosphere catches the heat of the sun and keeps our planet warm (Figure 1).

S. Stec and B. Baraj (eds.), Energy and Environmental Challenges to Security,

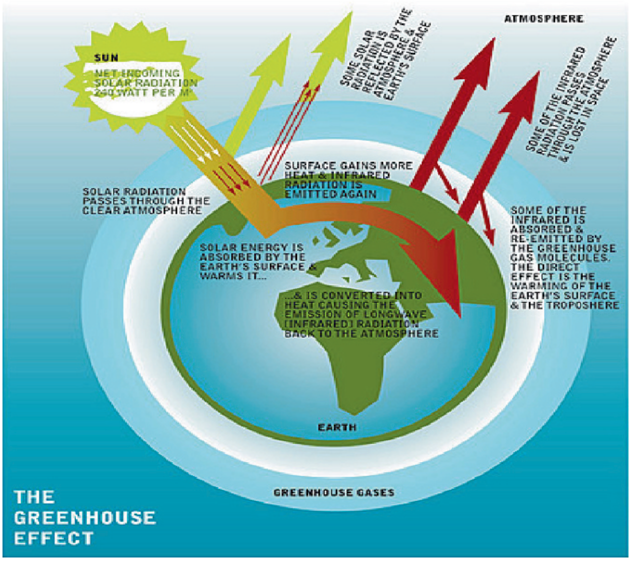

Figure 1. Greenhouse effect.

The Earth's atmosphere has continuously changed over the past 4 billion years. The temperature of the atmosphere and the surface has also changed. The causes of these changes are changes in the distance between Earth and the sun, the angular offset of the planet, and the evolution of vegetation.

Figure 2 shows that there have been drastic changes in the climate, but in the last 10,000 years the temperature was quite stable. Scientists have already proven that the last ice age is not over yet, so a rise in temperatures is normal, but the emission of more and more contaminants not only accelerates the rise in temperatures but affects natural processes.

The pollution of the atmosphere may come from natural sources like volcanoes, marshes, etc. The other form of pollution is from human activities, the majority of this form consisting of greenhouse gases. These are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (NO_x) (Figure 3).

Carbon dioxide is naturally present in the atmosphere and does not directly threaten human health, but it is the main cause of the greenhouse effect, which contributes to global warming. The quantity of carbon dioxide in the atmosphere has natural regulators, like plants, which use it for their life processes (photosynthesis). The oceans can also absorb CO_2 if the temperature of the surface is not too high. If the water is too warm, then instead of absorbing CO_2 it gives it off. The latter process will be more common in the future as the oceans' temperature rises. The anthropogenic emission of CO_2 increased due to the industrial revolution (Figure 4).

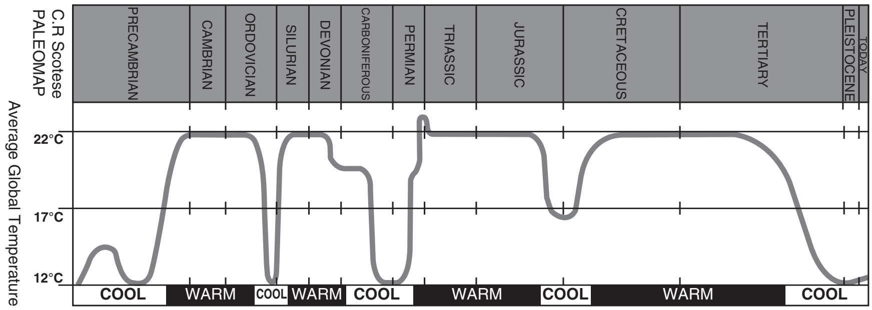

Figure 2. Changes in global temperature.

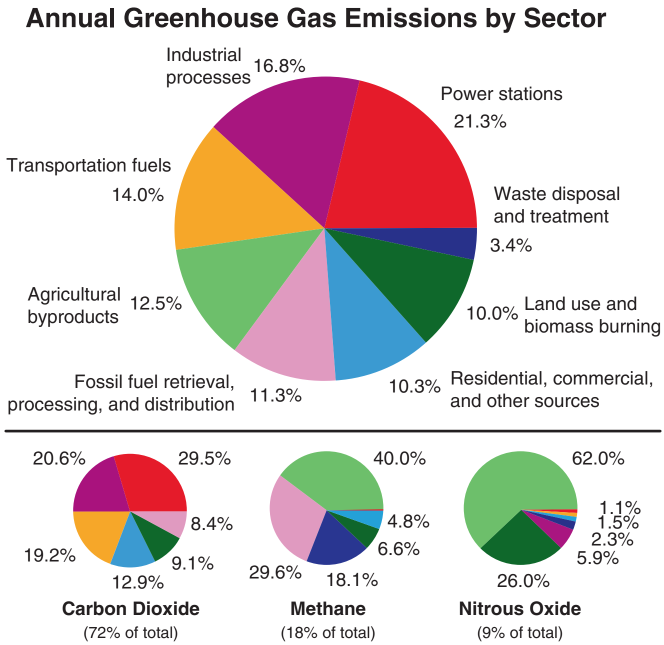

Figure 3. Annual greenhouse gas emissions by sector.

Nowadays it is already clear that there is a tight correlation between the level of CO_2 in the atmosphere and the temperature of the atmosphere (Figure 5).

The scientific evidence is now overwhelming: climate change is a serious global threat, and it demands an urgent global response. First of all, we have to cut down our greenhouse gas emissions. This is possible by diminishing our energy use and using renewable energies. These energies are constantly available, contrary to fossil fuels, and reproducible. These are solar, wind and geothermal energy and biomass.

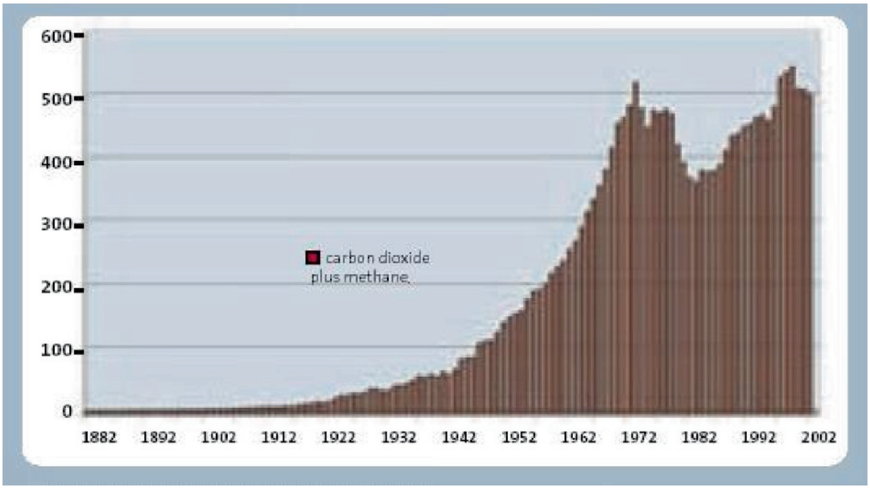

Figure 4. Greenhouse gas emissions over time.

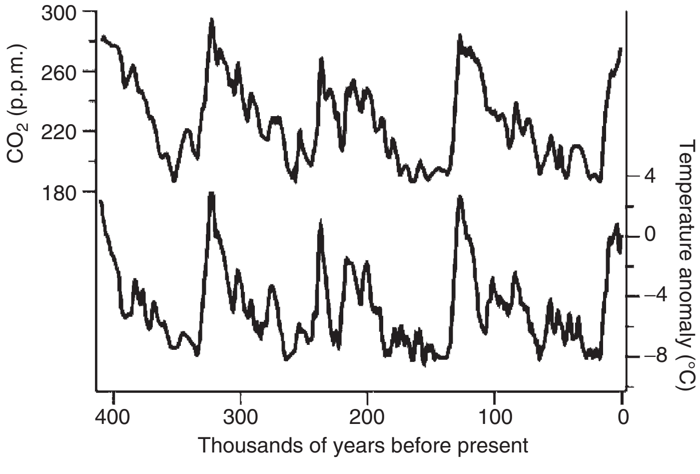

Figure 5. Carbon dioxide temperature anomaly.

2. The Effects of Climate Change on the Economy

British economist Nicholas Stern has written that the price of stabilizing climate change is high, but failure to do so would be very dangerous and much more expensive. If no action is taken to reduce emissions, the concentration of greenhouse gases could reach double its pre-industrial level as early as 2035, virtually committing us to a global average temperature rise of over 2°C. In the long term there would be more than a 50% chance that the temperature rise would exceed 5°C. This rise would be very dangerous indeed, because it is equivalent to the change in average temperatures from the last ice age to today. Even at more moderate levels of warming, all the evidence shows that climate change will have serious impacts on world output, on human life and on the environment. All countries will be affected. The most vulnerable – the poorest countries – will suffer earliest and most, even though they have contributed the least to the causes of climate change. It is no longer possible to prevent the climate change that will take place over the next 2 or 3 decades, but it is still possible to protect our societies and economies from its impacts. As scientists say, the risks of the worst impact of climate change can be substantially reduced if greenhouse gas levels in the atmosphere can be stabilized between 450 and 550 ppm CO_2 equivalent. The current level is 430 ppm CO_2 equivalent and it is rising at more than 2 ppm each year. Stabilization in this range would require emissions to be cut to 25% of the current levels by 2050, and perhaps much more. Ultimately, stabilization requires that annual emissions be brought down to more than 80% below current levels. Central estimates of the annual costs of this are around 1% of global GDP, if we start to take action now.

> *Action on climate change is required across all countries, and it need not cap the aspirations for growth of rich or poor countries.*
>
> *Nicholas Stern*

The costs of taking action are not evenly distributed across sectors or around the world. Even if the world's rich countries take responsibility for absolute cuts in emissions by 60–80% by 2050, developing countries must take significant action too, and these countries should not be required to bear the full costs of this action alone. The world's rich countries must support them. If we do not act, the overall costs and risks of climate change will be equivalent to losing at least 5% of global GDP each year, now and forever. If a wider range of risks and impacts is taken into account, the estimates of damage could rise to 20% of global GDP or more. The world does not need to choose between averting climate change and promoting development. Tackling climate change is the pro-growth strategy for the longer term, and it can be done in a way that does not cap the aspirations for growth of rich or developing countries.

3. Renewable Energies

We can call an energy source renewable if in the course of utilization the source does not reduce and we can later produce energy from it. For example, the sun will shine later also, but the traditional fuels of automobiles are not reproducible – we will run out of oil.

Renewable energies include solar energy, wind energy, energy from biomass, hydro energy and geothermal energy.

Wind energy: utilization of energy which can be captured by wind turbines in constantly windy areas. Humanity has been using wind energy since ancient times with sail boats or windmills. Today we can already produce electricity with the help of wind turbines. Europe leads the world in the technology and production of wind power, with 74% of worldwide generating capacity and 90% of the market for generating equipment. Germany, Spain and Denmark are the leading producers. The first wind turbine in Hungary was located 59 km from Budapest in 2001. It produces 1,250,000 kWh electricity each year, which is enough for 750 families.

Of course there are a few objections to the use of wind turbines. To begin with it is a very expensive technology, recovering its costs only after some years. The older types were also very noisy.

Geothermal energy: our earth's interior – like the sun – provides heat energy from nature. This heat – geothermal energy – yields warmth and power that we can use without polluting the environment. One kilometer from the surface, the Earth's temperature rises 30°C, but, for example in Hungary, the temperature is already 100°C 2 km from the surface. This heat is created by geothermal energy from rocks. Geothermal power works continually, day and night, providing baseload power. From an economic view, geothermal energy is extremely price competitive in some areas. The heated groundwater can be used for directly heating homes and greenhouses, for vegetable drying, and for a number of other uses. These are known as direct uses of geothermal energy. Geothermal energy is also used for electricity production. The disadvantage of geothermal energy is the high salt content of the water.

Solar energy: the flow of energy from the sun. The primary forms of solar energy are heat and light. The Earth receives 173×10^{12} kW of solar radiation per year, which is a thousand fold more energy than we need. Each year we receive as much energy from the sun as we can get from the burning of 60 billion tons of crude oil. Unfortunately, there are some problems with the collection of solar energy. First is the periodicity, only daytime and on clear days. The second problem is the very high price of the collectors, boilers and other equipment.

Biomass: refers to living and recently dead biological material, which can be used as fuel or for industrial production. Biomass is a collective term for all plant and animal material. A number of different forms of biomass can be burned or digested to produce energy. Biomass is the Earth's most important form of renewable energy. Until the 17th century, biomass was the only energy supply of mankind.

Sources of biomass:

- Secondary products of agricultural crops (straw, corn-stalk, corn-cob, etc.)
- Plants produced for energy supply (rape, sugar beet, various trees)
- Animal produced biomass
- Secondary products from tree cutting (slivers, sawdust, etc.)

Water energy: usually called hydro power, supplied from rivers and oceans, a renewable and reliable energy. Mankind has used the energy of water from the very beginning of civilization. In China, Mesopotamia, and Egypt water wheels were used for irrigation and for drinking water. At the time of the Roman Empire people already used water mills. The first power station was built in 1896 on the Niagara Falls, engineered by Nikola Tesla. Hydro power is created by capturing energy from moving water. Usually, hydro power works by capturing the potential energy of dammed water, which drives a water turbine and generator as it is piped down a hill at high pressure.

4. The Effects of Renewable Energy on the Economy and Security

Renewable energy is beneficial to sustainable development, it helps ensure the security of the energy supply, and it does not raise the concentration of greenhouse gases in the atmosphere. Usually there are significant domestic sources of renewable energy, so they lessen dependence on other countries. These are the common ideas about renewable energy. As usual the question is much more complex. Let us think about biofuels first. Biofuels are carbon neutral, because when we burn them we emit as much CO_2 as the plants have absorbed before, so contrary to fossil fuels, they do not raise the CO_2 concentration in the atmosphere. Furthermore, as analysts say, they develop agriculture and create new jobs, because biofuels are marketable in Europe and the United States. Additionally, plants used for biofuels are produced domestically, so they lessen dependence on the crude oil export countries, like Russia or the Middle-East countries. If we contemplate only these attributes of biofuels, then they are the rescuer of humanity. They do not pollute the environment, do not unleash wars and also develop agriculture and the economy. That is why biofuels became so popular with European and American politicians. The European Union decided to raise the rate of biofuel use to 5.75% by 2010 and 10% by 2020. The United States appropriated 27% of the whole fuel market by 2017. They subsidized the production of these crops, so new large-scale investors appeared in the market and investments grew 800% in the last 3 years. But according to calculations, to reach the 10% rate in Europe, 70% of the cultivatable lands are needed and in the United States all the produced corn and soy should be used for biofuels. Because of that the price of food would increase astronomically, states would need to import food, and jobs would be lost, because with the production of these crops fewer workers would be needed. That is why the developed countries want to import biomass for biofuels from developing countries. This would also help the economies of these countries. The top biofuel producer in the world is Brazil, where soy and sugarcane are produced, and Indonesia, where the top product is palm oil. Of course these countries try to meet the new enormous demand, but they use very environmentally destructive processes. As a NASA study writes, the price of soy in the world market is directly proportional to the clearing of rain forests. In Brazil, the clearing of rain forests has reached the terrible rate of 325,000 km^2 a year. The same situation evolved in Indonesia, and if they do not lessen clearing there will not be any trees by 2022. This would cause an ecological catastrophe and the island would be uninhabitable because of the disappearance of soil, the change of climate, etc. So biofuel is absolutely not environmentally friendly. The crops planted in place of the rain forests can absorb much less CO_2 than the rain forest itself, so the real emission of biofuels is tenfold that of fossil fuels. Furthermore, to produce these crops, many fewer workers are needed than for food crops, so unemployment would increase in these areas. The price of food is a great problem also. To produce 100 l of biofuel takes as much corn as the food energy needs of a normal man for a year. Additionally the production of corn requires 33% more fossil energy than the biofuel energy we can retrieve from it. In the beginning of 2007, there was a so-called "tortilla rebellion" in Mexico because the price of corn suddenly doubled on account of increased buying of corn for the American market. The price of corn directly endangered the life of 2.7 billion humans. While 10% of sugar production is used for biofuel, the price of sugar in the world market also doubled. So the uncontrolled production of biofuels has dangerous security, economic and social risks.

Another source of renewable energy is water. The material welfare of the world's population depends on maintaining access to increasingly scarce water and energy resources. Irresponsible use of water creates several problems. Water is absolutely necessary to our lives. We water, wash and cook with it and we can use it for the creation of electric and kinetic energy.

Today water is available in an almost unlimited volume, but the supply can run out. Overuse and pollution of waters generate serious problems all over the world. The building of a hydroelectric power station in a country may affect the water supply of another country located downriver. Such situations pressure the safety of a country significantly, because of its water dependence. For example the Atatürk dike system that dams the water of both the Euphrates and Tigris rivers has an effect on the water supplies of Syria and Iraq. This exacerbates conflicts among these territories with high security concerns.

Water usage has an effect on a country's agricultural and economic performance. Saudi Arabia sets a precedent for the most irrational use of water.

Seventy-five percent of its water supply is subsurface water that is incapable of renewal. Utilization of the water resource has resulted in prolific desertification. In the past the country was agriculturally self-sufficient and was even a grain exporter, but today the water supply has decreased to the point of no return.

Reservoir construction can cause exaggerated changes in a river's runoff. For the sake of the Aswan Dam 10% of the Nile's runoff goes to the sea. In highly polluted waters, 20 commercial genuses were fished out during the last 30 years; accordingly the fishing industry decreased notably. The Yellow River did not reach the sea an average of 3 months of the year this last decade. The river's runoff went from bad to worse and is becoming increasingly polluted. Resident populations are nevertheless obliged to use water where the concentration of heavy metals is above safe levels.

Since the 1970s Lake Amur became arid as the Amu-Darja and Sir-Darja rivers, for the sake of water supply, did not reach it. Additionally, the lakebed is very polluted with radioactive sand and the wind blows the sand to the cropland.

To satisfy the increase in human demand for water, more and more land area must be involved, and this fact is pregnant with consequences. In South-East Asia many of the rivers are so contaminated that the waters are unsuitable for consumption even after treatment. Accordingly the population uses groundwater; however these artesian wells usually include arsenic.

There have been 200,000 arsenic poisoning cases in West Bengal and probably half the Bangladeshi population (62 million people) is involved.

Water is a stark problem for Mexico City too. Since it does not have enough above ground water authorities have to pump subsurface water to meet the citizens' needs. Because of this the city started to sink by an extraordinary 2 cm per month. In 1994, the year of the Mexican economic crisis, instead of asking for financial help the state asked the United States for 2.8 billion cubic meters of water from the Rio Grande. For the sake of the American farmers the USA refused the Mexican demand. A possible conflict area is the Nile, affecting Egypt and Ethiopia. Eighty-six percent of the Nile's stock of water originates in Ethiopia, and Egypt depends on the Nile for 97% of its water needs. Egypt has already threatened war several times if Ethiopia tries to increase its own water consumption.

We can understand from these examples that the use of water presents a number of security risks. Supposedly, the decrease of water and fossil fuels will be the biggest problems for mankind in the near future.

5. Conclusions

Climate change is the top challenge of mankind for the future, and man is one of the causes of climate change. The problem is so serious already that without any action terrible economic, environmental, social and security problems are bound to happen. For their prevention we must lessen our CO_2 emissions, which can be done by using much less fossil fuels. Currently the best hope for reduction of the use of fossil fuels is renewable energy. But sources of renewable energy also have security risks. The solution is somewhere halfway. We should lessen the use of fossil fuels, but we must control the use of biofuels and reserve our water supply for future generations. States should subsidize the more expensive renewable energies, like solar energy, wind energy and geothermal energy, that present a lower level of risk as compared to biofuels or hydro energy.

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ENVIRONMENTAL PERFORMANCE

STOCHASTIC SIMULATION AS AN INSTRUMENT FOR TECHNOLOGICAL SYSTEMS ENVIRONMENTAL PERFORMANCE

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Abstract: The ecological footprint of rapidly growing technological systems becomes excessively high compared to the limited carrying capacity of the global eco-system. Decoupling industrial output from energy consumption challenges the post-Brundtland society to shift towards a new kind of technological progress. Stochastic simulation could serve as a powerful instrument for this by helping to improve overall performance through design and management of technological systems, achieving win–win results for the common benefits of entrepreneurs and the environment, and mitigating the ecological footprint of technological systems.

The levels of power consumption of the systems in question as well as their energy intensity of output are quite important indicators of overall performance. Using stochastic simulation we can reproduce all the details of the systems in question, including functioning, optimizing operations management, and eliminating redundant losses of operating time and therefore losses of energy and material flows.

To describe the real processes involved in the running of technological systems we use stochastic discreet models (Shannon, 1973; Carroll, 1985; Taha, 1997). The duration of operations is depicted by the Erlangian model, which describes a broad continuum of cases: from pure stochastic (Erlangian parameter or order of distribution $\boldsymbol{k} = \boldsymbol{1}$) to deterministic ($\boldsymbol{k} = \infty$). Using data about a mean operations duration and order of Erlangian distribution $\boldsymbol{k}$ collected from real transfer lines, we developed stochastic discreet models, which quite precisely describe real processes (accordingly to chi-square criteria) and, applying the method of inverse functions (Taha, 1997), we used these models to simulate processes of technological systems functioning with the aim of investigating and optimising their management and eliminating redundant time and energy losses (Dudyuk and Zahvoyska, 2003). Relevant examples introduced in the paper clearly illustrate the eco-efficiency of technological systems redesigning and/or proper management.

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1. Introduction

According to ecological economists we are approaching a "full world" (Daly and Farley, 2003) where opportunity costs of economic growth are significant. We simply do not know where the Plimsoll line is, which separates economic growth from non-economic growth. But, nevertheless, we are approaching it too quickly and do not fully recognize the danger. Indeed, we do not hesitate; in producing or consuming goods and services, we do not think about the economy as a system that transforms low-entropy matter and energy taken from nature, into high-entropy goods, services and residuals, which should be absorbed by nature at some point in time. We merely forget or close our eyes to the fact that these transformations are not a pleasure for us and the overall ecological footprint exceeds the global ecosystem's carrying capacity.

Thinking about the economy from the thermodynamics perspective we arrive at a point where the ecological footprint should be reduced and the ecological rucksack must be lighter. About half of the worldwide rucksack is due to energy conversion. The first step towards this is not so complicated or sophisticated. We just need to keep in mind that we waste a lot of resources (both material and energy) when producing finished goods and semi-finished products that will then be used in further production processes. Loss of resources is nothing less than loss of environmental quality and we can avoid it by saving material and energy inputs from the production/consumption process.

Energy production is an example of an especially harmful process from the environmental quality perspective: we extract scarce resources, we produce energy with an especially heavy ecological rucksack, we pollute a lot near us and share this with our neighbors and future generations, and, finally, we use such "environmentally intensive products" as electricity with low efficiency, especially at the end point of use.

The dominant market system does not send us relevant signals about full environmental costs and does not internalize them in market prices. Therefore, changing the behavior of producers and consumers to energy saving lifestyles and encouraging technological innovations seems to have more considerable potential impact on driving the economy towards a sustainable future.

The ecological footprint as a headline indicator for the quality of economic growth without controversy shows that humanity uses more than the earth's capacity. The ecological debt of 0.4 global hectares per person (Wackernagel et al., 2002 cited in Lawn, 2006) when the population is over 6 billion people reflects the non-sustainable character of recent human development and the depletion of natural capital. Through this, modern enterprises are faced with growing environmental challenges.

Energy systems, which involve all stages of the energy chain from resource extraction and treatment through conversion and distribution technologies to energy services, are linked to serious natural capital damage. Therefore re-shaping and re-designing whole energy systems and especially end use efficiency are needed to ensure energy security, efficiency, and a win-win-win strategy for society.

As outlined in the UNDP policy agenda paper, "Energy for Sustainable Development" (Johansson and Goldemberg, 2002, p. 34), over the next 20 years the amount of primary energy required for a given level of energy services could be cost-effective if reduced by 25–35% in industrialized countries and from 30% to more than 45% in the most-developing countries, which tend to have high economic growth and old capital and vehicle stocks. The improvement could be achieved by a shift to less energy-intensive production and consumption. Regarding the business-as-usual environment, the second option can be tackled both through technological systems re-design and management improvement.

Technological systems (TS) can be interpreted as complex dynamic systems that combine industrial facilities, monitoring and control devices, subsidiary and transport means, production inputs and personnel to carry out production processes. Modern TS are exposed to a variety of disturbances caused by human, technical and/or environmental impacts. Current operations management does not provide well-grounded recommendations on how to design, organize and manage TS to achieve the best performance under existing conditions. A lack of relevant suggestions regarding the optimal TS structure (optimal way of facility layout, succession of productivity, conversion units, number of workers per facility unit, etc.) results in redundant time losses, which entail energy waste and grow a heavy ecological rucksack.

Simulation techniques could provide us with relevant information regarding particular characteristics and pros and cons of a variety of technological systems alternatives and help us to obtain win-win-win solutions for improving their overall performance. Stochastic simulation models particularly enable us to incorporate plenty of accidental factors into the simulation model and later processes that lead to a realistic and well-specified description of systems and processes in question and further their optimal design and management.

2. Technological Systems Simulation Methodology

Simulation as the substitution of a real-world system by its adequate virtual analogue is a powerful and straightforward technique, which is good for analytical purposes. It helps the investigator to acquire a good understanding of overall systems, and provides him with missing information about different situations and case studies. It may illustrate the model development process, or allow one to better comprehend the process in question, or understand relationships within the decision-making setting.

Stochastic simulation is commonly used for optimising design and management of complex queuing systems because of the inability to generate meaningful analytic solutions for such structures (Budnick et al., 1988; Noori and Radford, 1995; Schonbergen, 1991). To generate a discreet (event-oriented) stochastic simulation model one should explore an appropriate distribution law and its parameters, which sufficiently allow the precise imitation of processes in question.

A manufacturing process consists of several elementary conversion operations (or strokes). Our investigations show that the duration of a whole process (any operation of a process) can be adequately described by *generalized Erlangian distribution of order* **k** if elementary operations (strokes), which make up the process (operation), are submitted to exponential, Erlangian or β-distributions or even some of them are deterministic (Dudyuk et al., 1996).

Let us be reminded that the model of Erlangian distribution of order $\boldsymbol{k}$ ($\boldsymbol{k}$ is Erlangian parameter, coefficient of stability) can be noted in the following way:

$$F(t) = p\{T < t\} = 1 - e^{-\frac{kt}{m}} \sum_{i=0}^{k-1} \frac{\left(\frac{kt}{m}\right)^i}{i!}, \tag{1}$$

where $F(t)$ – distribution function,

$\boldsymbol{T}$ – duration of a process (operation),

$\boldsymbol{t}$ – period of time,

$\boldsymbol{m}$ – mean duration of a process (operation).

In the case that order $\boldsymbol{k} = \boldsymbol{1}$, Erlangian distribution gives exponential one, and in case $\boldsymbol{k} = \infty$, Erlangian distribution gives deterministic one (Figure 1).

Let a manufacturing process consist of $\boldsymbol{n}$ elementary conversion operations. Then duration of a manufacturing process (conversion operation) $\boldsymbol{t_P}$ in

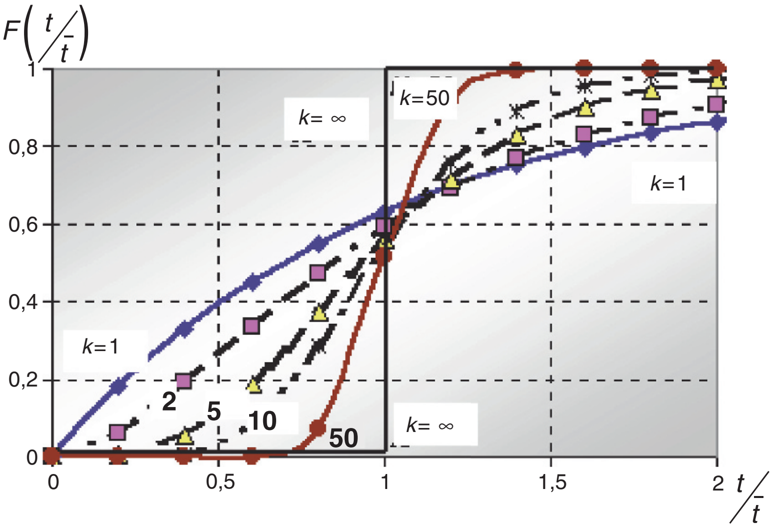

Figure 1. Erlangian distribution function of relative duration of operation in overall conversion process duration $t/\bar{t}$ for different k.

a technological system is a linear function $\boldsymbol{F(t)}$ of $\boldsymbol{n}$ independent parameters (durations of separate operations) both deterministic ($\boldsymbol{t_{di}}$) and stochastic ($\boldsymbol{t_{si}}$), which are submitted to exponential or Erlangian distributions, will be described by generalized Erlangian distribution of order $\boldsymbol{k_p}$:

$$F(t) = p\{t_P < t\} = 1 - e^{-\frac{k_P t}{m_P}} \sum_{j=0}^{K_T - 1} \frac{\left(\frac{k_P t}{m_P}\right)^j}{j!} \tag{2}$$

with such parameters:

- Expected value of duration of a manufacturing process (a conversion operation)

$$m_P = \sum_{i=1}^{n1} m_{s_i} + \sum_{i=n1+1}^{n} t_{d_i}, \tag{3}$$

- Variance of a manufacturing process (a conversion operation)

$$D_P = \sum_{i=1}^{n1} D_{s_i}, \tag{4}$$

- Erlangian parameter

$$k_P = \frac{m_P^2}{D_P} = \frac{(\sum_{i=1}^{n1} m_{s_i} + \sum_{i=n1+1}^{n} t_{d_i})^2}{\sum_{i=1}^{n1} D_{s_i}}, \tag{5}$$

where m_s^i *i* D_s^i – expected value and variance of an elementary stochastic operation (stroke) *i* correspondingly ($i = \overline{1, n1}$).

(In the case of a manufacturing process consisting of two conversion operations [*n* = *2*] with stochastic duration, and k_1 and k_2 are Erlangian parameters for the first and second operations correspondingly, an Erlangian distribution function of relative duration of the whole process [operation] in question is shown in Figure 2.)

Our investigations (Dudyuk and Zahvoyska, 2003) show that Erlangian parameter $\boldsymbol{k_p}$ of a manufacturing process (a conversion operation) always belongs to the interval

$$[\min k_i; \sum_{i=1}^{n1} k_i], \tag{6}$$

where ***n1*** – a number of stochastic operations (elementary operations), which make up the process (operation),

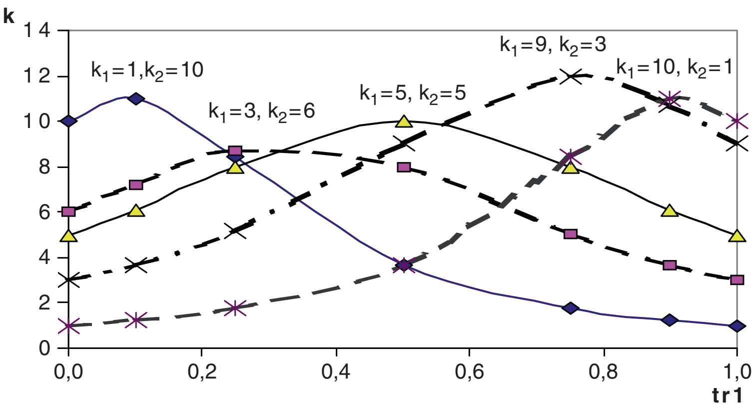

Figure 2. Behavior of Erlangian parameter ***k*** in case of two elementary operations (*n* = 2) t_{r1} – relative time of the first elementary operation; k_1 and k_2 – Erlangian parameters for the first and second operations correspondingly.

$\boldsymbol{k_i}$ – an Erlangian parameter of an operation (elementary operation) $\boldsymbol{i}$. This parameter varies from 1 to 200 for typical wood processing operations and from 1 to 500 for engineering ones.

The correlation (6) means that in the case of joining several operations, the generalized Erlangian parameter $\boldsymbol{k_p}$ of total process always will be not less than the minimal value of the corresponding parameters across all components. The maximum value of the generalized Erlangian parameter $\boldsymbol{k_p}$ will be reached when components have similar characteristics (similar values of means and Erlangian parameters for all components) (Figure 2).

For our further investigation let us introduce the generalized Erlangian parameter of a whole process $\boldsymbol{k}_p$ as a function of facility reliability, which can be measured using a coefficient of reliability $\boldsymbol{K}_r$, a ratio of working time in total (working and repairing) time:

$$k_P = \frac{\bar{t}_P^{\,2}}{D_P} = \left[\frac{\kappa_r^2}{k} + (2\frac{\bar{t}_W}{\bar{t}} - 1)(1 - K_r)^2 \right]^{-1}, \tag{7}$$

where $\bar{\boldsymbol{t}}_p$, $\bar{\boldsymbol{t}}_w$ – mean duration of a manufacturing process and mean working time correspondingly;

D – variance of duration of a conversion process;

$\bar{t}$, k – mean duration of a conversion process and Erlangian parameter for ideal facility ($\boldsymbol{K}_r = 1$) correspondingly.

This correlation (7) reflects the huge role of reliability in TS modelling. Our investigations (Dudyuk and Zahvoyska, 2003) show that the high probability of facility breakdown (low values of a coefficient of reliability, $\boldsymbol{K}_r <$ 0.75) makes the Erlangian model inadequate for real processes. For these cases duration of working and repairing time should be generated separately. In all other cases (a coefficient of reliability $\boldsymbol{K}_r >= 0.75$) the integrated time of manufacturing process duration will correctly reflect real processes. As it comes from correlation (2) to simulate a real manufacturing process (a conversion operation) we need to know the mean value of the process (operation) in question's duration and variance (or stability).

Such a methodological background was examined by Ch. Pirson using empirical data collected at wood processing enterprises and X^2 criteria. The results obtained prove that Erlangian distribution adequately renders real world processes.

In the scientific literature one can find a lot of examples of using stochastic event oriented techniques for the investigation of steady-state operation characteristics of models, which are common for multi-stage transfer line systems. We widely apply stochastic simulation techniques for investigating the optimal parameters of $E_k/E_k/m$ systems design and management. Let us consider an example of such an application.

3. Example of a Technological System Simulation

Modern TS tend to link equipment into multi-stage transfer line systems. These transfer lines are the automated production flow lines in which a series of processing or assembling operations is performed on production units in order to convert the production inputs into outputs by interconnected automatic stations and/or stages. Although these lines have obvious advantages they still have undoubted shortcomings. A line production rate never increases over 60–80% of the lowest individual nominal productivity. The manner of linking strongly influences this rate. Engineers and economists try to derive more reliable estimations of line production to design the optimal facility layout in the line framework (Okamura and Yamashina, 1983; Gershwin, 1994; Vladzievskiy, 1958; Dudyuk et al., 1996). The diversity of approaches reflects both the complexity of the task and recognition of its importance in decision-making.

The Russian scientist A. Vladzievskiy (1958) proposed to rank facilities according to their nominal productivity and to arrange them in declining order. The Japanese scientists K. Okamura and H. Yamashina (Okamura and Yamashina, 1983) proposed to rank production rates of machines creating the line in question and arrange the ***n***-stage line in the following way: "the lowest production rate should be in the ***n***-th stage. The second lowest in the first stage, the third lowest in the (***n***-1) stage, the fourth lowest in the second stage and so on" (Okamura and Yamashina, 1983). Our task was to check and compare these rules and, if they are wrong, to formulate an optimal on.

Simulation allows us to estimate productivity of each alternative model of machinery layout taking into account the stochastic influence of such factors as machinery breakdowns and wooden detail features. Our stochastic event-oriented model (Figure 3) was aimed at discovering the relationship between the production rate of multi-stage transfer line systems and the manner of linking machinery. To facilitate a comparison of the different layout alternatives we estimated the relative productivity of transfer lines assuming the lowest nominal productivity across all units to be equal to one.

We conducted a series of computer experiments (runs) for the different number of stages and reliability of machinery. Such comparisons ensure identification of a rule for maximising the productivity of transfer lines for a different number of stages in lines (Zahvoyska, 1999). This rule can be formulated through the following algorithm:

1. To calculate the relative productivity of units in line, to range them in the ascending order and to assign them ordinal numbers, let's say from 1 to ***n***.
2. To create such pairs of the machines' productivity (see Figure 4):
   - {1, n}; {2, n-1}; {3, n-2}; …; {n/2, n/2 + 1} for even *n;*

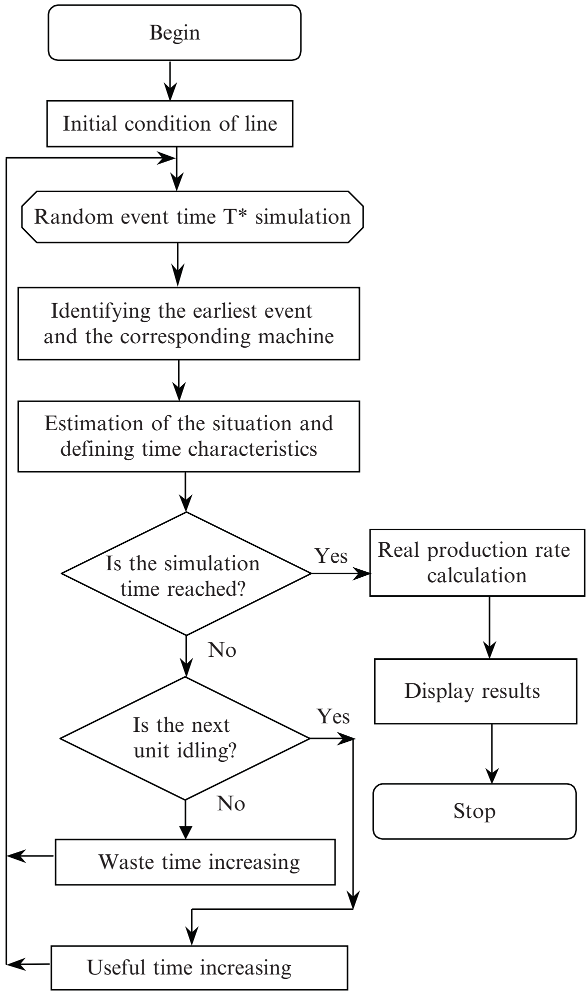

Figure 3. Logic of multi-stage transfer line system simulation.

- {1, n}; {2, n-1}; {3, n-2}; …; {(n-1)/2, (n + 3)/2}; {(n + 1)/2} for odd *n*.

3. To place the first pair at the beginning of the line, the second pair at the end of the line, the third pair just after the first one, and the fourth pair just before the second, in other words to place the pairs step by step from both ends to the middle of the line.

The dependence on the relative productivity of multi-stage transfer lines on machinery layout is presented in Figure 5. It is worthwhile to note that increasing the number of stages leads to a more significant increment in

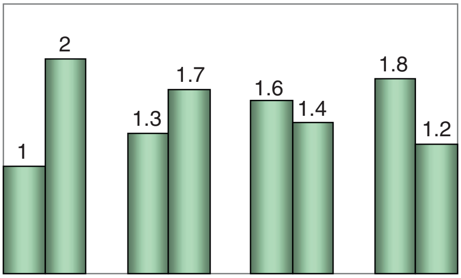

Figure 4. Layout of productivities.

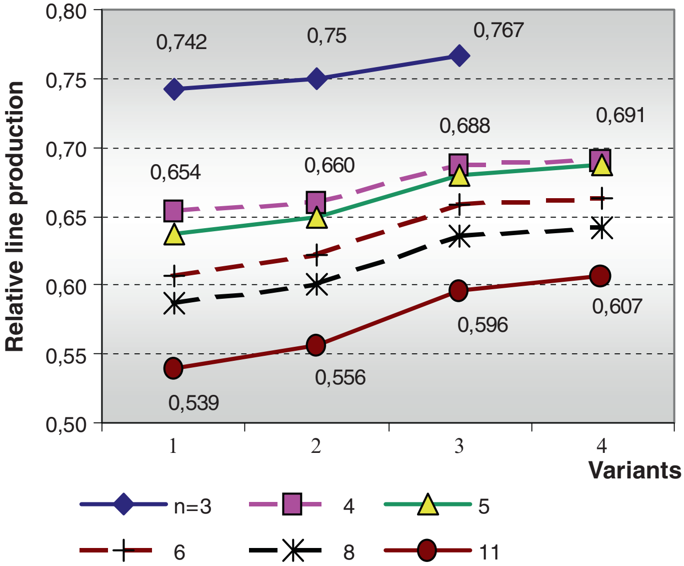

Figure 5. Dynamics of relative line production. Variants of facility layout:
1. The lowest productivities centralization
2. Descending (ascending) ordering
3. The highest productivities centralization
4. Proposed algorithm

system productivity. The proposed algorithm gives an increase of average productivity in multi-stage transfer lines by 7–12% when the number of machines in the line varies between 7 and 11.

This rule can be successfully used in order to remove "bottle-necks" in places on the production chain or servicing systems. It could be useful to rearrange the facility layout of working lines and to design new, advanced and efficient ones. And it should be relevant in choosing facility renovation and modernization alternatives. These findings result in saving energy at the last stage of the energy chain, the most expensive and resource intensive. Producers will increase the overall performance of technological systems: decrease duration of the manufacturing process with simultaneous improvement of the working time structure as a result of minimising time loss with the saving of indirect production costs bringing significant prime cost reductions. All these profitable changes will lead to easing the environmental footprint of the production process.

4. Conclusions

One of the priority-driven tendencies of production systems development is to make the systems in question more eco-efficient. It means arranging production as less resource intensive, leaner and more environmentally friendly. Operations research enables decision makers to find the optimal structure and management of the systems in question. Stochastic event-oriented simulation models particularly create realistic representations of the processes being analysed so that they allow us to obtain quantitative estimations of alternative strategies and later to generate optimal ones.

The analysis of examples of simulation applications for the optimisation of multi stage-transfer line manufacturing systems brings clear ideas about the utility of such modelling techniques. Increasing line productivity and decreasing line tact means that time and energy losses will be minimized and all production resources (material, labour and financial) will be used in a more efficient way for the common benefits of producers and society.

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INTEGRATED MANAGEMENT AND ENVIRONMENTAL CLEAN-UP OF CONTAMINATED AREAS AROUND THE INDUSTRIAL AREAS OF ELBASANI IN ALBANIA

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Abstract: The World Bank declared that the area located around the metallurgical complex of Elbasan is one of Albania's most important "hot spots" [12]. The region is endowed with good soils and climate. Elbasani district is the major agricultural area of the country, providing produce to both the Elbasan area and Tirana. However, because of the industrial activity of the metallurgical complex, the soils around it are very contaminated by heavy metals such as cadmium, nickel, chromium, lead, and copper. Consuming vegetables and other crops grown in this area presents a serious health risk to those eating these products. Immediate action is required to ameliorate the situation generally since all the natural resources (soil, water and air) have been contaminated. Sustainable development of this area, based upon our long-term strategy, will increase the incomes of the associated communities, increase their property values, and improve the health situation. To achieve these goals, we conducted a field research/demonstration program illustrating appropriate cropping systems, demonstrating to farmers the potential of particular plants to extract heavy metals from contaminated soils, and organizing within the study zone an educational program for both the local farmers and local authorities.

1. Introduction

The World Bank declared that the area located around the metallurgical complex of Elbasan is one of Albania's most important "hot spots" [11, 12]. This is the biggest metallurgical complex in Albania. It was built by the Chinese in 1976 and is currently operated by a Turkish firm. It has a treatment capacity of 800,000 t per year of iron–nickel ores. This metallurgical operation, although still using the original technology installed in 1976, plays a central role in the industrial base of the Elbasan area. Not surprisingly, its impacts on the environment are extreme. According to the World Bank, this metallurgical combine released in 1991 an estimated 44.8 t of toxic dust/year. The contaminants emitted from this complex have, perhaps, the most effect on the Shkubini River, the main watershed for the region. As a result, the Shkubini is among the most polluted rivers in Albania [5, 6]. Nevertheless, its waters are used to irrigate agricultural crops downstream.

The pollution emitted from this complex has caused many problems for the microenvironment and has had adverse effects on the health of various categories of peoples, especially pregnant and lactating women. Problems of professional diseases are very evident in this area. They have been caused by the presence of toxic gases, vapors, and dust. The World Bank observed in 1993 that flora modifications are generally present on soils contaminated by industrial and mine discharges. Consequently, the impact of this complex on the agro-environment cannot be dismissed, not least in Albania where laws preventing such discharges, if existent, are not enforced.

According to statistical data [1–3], Elbasani district is one of the major agricultural areas of the country, providing produce to both Elbasan and Tirana. The region is endowed with good soils and climate. However, because of the industrial activity of the metallurgical complex, the soils around it are very contaminated by heavy metals such as cadmium, nickel, chromium, lead, and copper. Consuming vegetables and other crops grown in this area presents a serious health risk to those eating these products. Our scientific data [7–10] shows that the level of cadmium is up to 3 mg/kg of soil, nickel up to 695 mg/kg of soil, chromium up to 630 mg/kg of soil, lead up to 120 mg/kg of soil, and copper up to 244 mg/100 kg of soil. These soils are, therefore, very contaminated and require attention. The adverse effects on the human population include the following: (i) loss of high quality farmland and private and public property values, pollution of soil and groundwater, (ii) enhanced demand for clean water, contamination of urban areas, and increased public health problems, and (iii) low grazing quality, reduced crop yields and livestock production.

Immediate action is required to ameliorate the situation generally since all the natural resources (soil, water, and air) have been contaminated. Sustainable development of this area, based upon our long-term strategy, will increase the incomes of the associated communities, increase property values, and improve the health situation. This paper assesses the impact of the management and use of natural resources on sustainability for the farmer and his production methods.

1.1. DESCRIPTION OF THE AREA

The study was conducted in Elbasani district in the area located around the metallurgical complex. Elbasani District is situated in the central area of

Albania. The district is 3,292 km^2 in area and has a varied topography with more than 70% of the area being comprised of hills and mountains, the latter reaching altitudes exceeding 1,411 m. Climate changes are significant due to the broken mountainous relief, characterized by an average precipitation between 900 to 1,300 mm and altitude between 70 to 128 m above sea level. The annual average rainfall is 1,170 mm but in mountainous areas it may reach 2,000 mm. The amount of agricultural land per capita in Elbasani region is about 0.22 ha and the average farm size is about 1–1.3 ha [1]. Loam soils dominate the Elbasani area, comprising about 45% of the district's soil cover. Clay and sandy soils make up approximately 35% and 20% respectively [15]. The soils in the mountainous regions of the district are very shallow and their vulnerability to erosion, due to their shallowness and topography, is high. These soils represent in total about 55% of the total arable area in the district. Production systems remain primitive, yields remain low, many farms are too small and fragmented to be viable, physical infrastructure is poor, and private sector activity has yet to fully fill the vacuum left by defunct state processing and marketing enterprises. The family farms are mixed operations of cereals, fruits, vegetables, and livestock. Only a limited number of farms, mainly those located close to urban areas, practice a more intensive form of agriculture that allows them to produce for the market. During the transition the support structures for agriculture disintegrated. The already poorly functioning irrigation system was made completely ineffective in the early 1990s. Elbasani region faces a number of serious environmental problems, some of which are directly related to agricultural activities both current and in the past. Probably the most serious environmental problem relative to agriculture is the heavy loss of topsoil and nutrients due to poor soil management and loss of natural vegetation, particularly on moderate to steep slopes. In the past, the use of chemical inputs was high, and a return to former levels of application could be probable if improved production and marketing opportunities are introduced. This could lead to nutrient overloading of natural waterbodies and contamination of both soil and water, particularly if large inputs of pesticides are used.

2. Rationale and Objectives

The overall objective of this study was to create and implement a viable strategy for the recovery of contaminated areas in Elbasan Prefecture, to provide a framework for long-term, integrated management of similar areas throughout Albania, and to improve crop productivity under sustainable natural resources management. The scientific approach used in this study emphasized participatory methods to ensure integration of indigenous knowledge and local experiences, in planning and implementation of agricultural technologies development. The project has coordinated the involvement of relevant local, regional, and national authorities, university students, and local farmers to plan and implement the project's strategies and activities. The results are expected to have a direct and positive impact on the productivity of these areas, on the reduction of contamination and protection of the areas in the study zone that are critical for agricultural production in this region. The rational use of these areas is also expected to halt the current degradation process that is most threatening to biodiversity and sustainability of ecosystems in these areas. Natural resource management issues were also incorporated by implementing field activities through a community-based approach that focused on the micro-watershed and on householders as basic implementation units.

3. Methodology

The premise of this study was that sustainable development depends on a good match between land quality and land use. Land degradation and unsustainable land use practices result when there is a mismatch. During the period 2002–2004, we conducted a study in two communes around the metallurgical complex of Elbasan, which are the major agricultural areas of this district, providing produce for a large part of Elbasani and Tirana. The region is endowed with good soils and good farming systems. However, because of the industrial activity of the metallurgical complex, the soils around it are very contaminated by heavy metals such as cadmium, nickel, chromium, lead, and copper. Consuming vegetables and other crops grown in this area presents a serious health risk to those eating these products. For that reason, the two communes were selected to typify the overall study area while allowing researchers to capture effects of localized features. The criteria for selecting the areas to be studied were that they should be representative of the soils and farming systems of the region. During the initial phase of the survey, we identified the required personnel, facilities, resources, and information already available on the ground to assist in project implementation. The survey data were collected to evaluate any changes over the last 10 years; to assess the attitudes and knowledge of farmers with respect to soil protection; and to consider the need for further guidance to alleviate any problems found. We provided a considerable amount of data on the soil, water, and air contamination. These data were derived from our previous studies in the region and were used as a baseline for the current project. The land area of the selected communes consisted of three to five villages with an average of about 900 ha supporting about 650 family farms. The first phase of the study focused on characterization of the land use systems at the household and community levels using a battery of participatory methods. This baseline information was used to describe the farming systems, the risk of soil contamination in the food chain system, the risk of vegetable cultivation in these zones for fresh production, etc. We also described the production constraints at the farm level and in the micro-watershed by establishing the current levels of the natural resources base, such as mean farm size and distribution, and available household labor. Farmers' strategies to manage these households' resources and exploit common pool resources were also established. Individual farmer interviews were used to identify different farmer categories in each commune, such as small group discussions, resource-mapping, etc.

The team surveyed farmers and participated in group discussions with them during project implementation. The objective was to assess the problems the local community faces, in their own words, in relation to farming and food production in the study zone. The team administered 200 questionnaires. A random sampling of farmers, organized according to farm size, farming system, soil characteristics, and irrigation capability, was delineated. The most extensive interviews and discussions took place with farmers who had very good farming systems and had faced a variety of problems. We recorded the farmers' views on soil management and soil protection issues on their farms. The farmers explained how they viewed problems on their farms and rated them according to the estimated seriousness of each. The second phase consisted of an extensive participatory on-farm trial, to evaluate, identify, develop, and promote the practices that were most productive and more easily adapted from the local community. These technologies aimed to increase soil organic matter content, prevent formation of soil crust and compacted layers through minimum tillage, and improve soil structure and water holding capacity (Table 1).

The project has offered solutions for long-term sustainable development, using appropriate technologies and emphasizing the need to make more and better use of those crops able to grow in contaminated environments, use crop residues more efficiently, introduce better crop rotations, promote relay cropping and improve pasture management. The experience and results of two ongoing field experiments in the Elbasan area were incorporated into the project. These field experiments (from 1998) tested the recovery of contaminated arable land through the use of hyperaccumulator plants (such as *Alyssum murale*). Metal hyperaccumulator plants are highly specialized species with the capacity to concentrate metals such as Zn, Ni, Cd and Pb to levels far in excess of normal physiological concentrations, in their upper plant parts [4, 8]. The use of such hyperaccumulator plants to extract metals from surface-contaminated land could represent a low technology, natural means

TABLE 1. Farming systems description of the study zone.

	Shrigjan	Bradashesh	Jagodine	Bujqez	Kuqan
Total area (ha)	720	1100	560	460	420
Project area (ha)	150	150	120	100	130
Total households (no.)	600	1300	490	480	360
Participants (household)	55	75	25	20	20
Mean farm size (ha)	1.2	0.8	1.1	0.9	1.15
% farmers aware about remediation techniques	22	9	15	20	25
% farmers ready to apply remediation techniques	85	75	85	80	90
% incorporate residue	80	50	70	65	75
Main crops	Vegetables Maize Wheat Forage	Vegetables Maize Wheat Forage	Vegetables Maize Wheat Forage	Vegetables Maize Wheat Forage	Vegetables Maize Wheat Forage
Minor crops	Tobacco Potatoes Fruits	Forage Potatoes Fruits	Tobacco Potatoes Fruits	Beans Potatoes Fruits	Beans Potatoes Fruits
Main soils	Sandy-loam	Sandy-loam	Sandy-loam	Sandy-clay	Sandy-loam

of in situ soil remediation. According to our scientific results *Alyssum* hyperaccumulator species take up nickel from soil at a higher level (2% DM), [8–10]. The analyses focus on the impact of land management on sustainable land use of farmers taking into account productivity, incomes, etc. During the project we presented data illustrating the effect of low soil fertility and metal toxicity limitations on plant growth. During these meetings, held in cooperation with officials from the local agricultural directorate, we suggested using improved agronomic practices. We suggested use of improved techniques such as: planting dates, fertilizer and mulching requirements, tillage operations, crop suitability, and optimal land use options. We discussed alternative farming practices with farmers based upon their specific operations. They were interested in what they could do to alleviate the negative health and agronomic effects of the soil contamination. As an integral component of the design and development process, aimed at incorporation of local knowledge in the field protocols, these groups were used in planning, implementation and evaluation. With our assistance they have organized, cultivated, and monitored field research and demonstration plots. We provided hyperaccumulator plant seeds for these field research/demonstration plots and then assessed the plants' potential for metal uptake and soil quality improvement. These field research/demonstration programs have illustrated the appropriate cropping systems. Also we have demonstrated to farmers the potential of particular plants to extract heavy metals from contaminated soils by showing the results of the plots cultivated, and the experience and results obtained from two ongoing field experiments in the Elbasan area, as well. The menu of options presented to farmers and included as treatments in the on-farm trial consisted of agricultural technologies which have been demonstrated to improve soil fertility and hence increase crop production under pollution conditions, and are currently under on-farm review. They consisted of farming systems based on crops that are capable of growing in polluted soils and characterized by a low "transfer factor" such as forage (alfalfa, clover), wheat, maize, etc.

4. Results and Discussion

Group discussions and individual contacts complemented each other in terms of the overall information collected and provided the possibility for farmers, scientists, and the agricultural directorate staff to confer on the description of land use systems, diagnosis of production constraints and identification of potential remediation technologies in the polluted areas.

The participation of farmers during all phases of the project gave them a high sense of ownership. Two major points emerged from our survey of the communes' rural areas: we must always look at the problem of soil contamination from the farmers' perspective and their sets of limitations and we must then enable them to see soil contamination as their problem, subject to solutions for which they must contribute their input. In addition to being technically effective, soil contamination control measures must fit the economic, social and psychological framework of farmers.

We have stressed these points in our overall management of the project and when communicating the project strategies to farmers, local officials, and national leaders. In general, farmers with smaller farm size had more interest in using remediation practices and cultivation of different crops able to grow at those sites.

Cropping in polluted soils and erodible slopes was more prevalent in villages located close to a city. Maize, wheat, vegetables and forage were grown extensively in all villages. There was a tendency shown of a reduction in the surface area cultivated with vegetables, mainly those consumed as fresh produce, and of the increase in the surface area cultivated with crops that have a low "transfer factor" of heavy metals in the food-chain system.

The data presented in Tables 2 and 3 give a clear view of the cropping patterns in the study zones. Examination of the initial selection of the remediation technologies and agricultural practices used in the on-farm trial showed farmers had more interest in crops that could provide incomes as well as improve soil fertility and could be safe for consumption. As a result of our education and training program in the study zone, the farmers started to change the cropping patterns and to grow hyperaccumulator plants such as *Alyssum Murale* in abandoned soils, which take up nickel from soil at a higher level, and reduce soil erosion.

For example, out of the 195 farmers involved in this study, 56% chose alfalfa as their first choice to cultivate on their farms. Results from individual farmer assessments indicated that there were no discernible differences in the performance of remediation technologies. Mean maize yield was about 5.8 t per hectare, wheat 3.5 t per hectare, alfalfa 40 t, showing a significant increase of yield in the second year of our project (Table 4).

Raising livestock is one of the most common agricultural activities. Although farm incomes generated from livestock are not comparable with

TABLE 2. Cropping pattern (ha) in study zone for year 2002.

NR		Shrigjan	Bradashesh	Jagodine	Bujqez	Kuqan
1	Vegetables	330	650	320	290	250
1.1	Spinach	30	50	20	10	20
1.2	Lettuce	80	160	110	60	50
1.3	Tomatoes	120	220	90	120	100
1.4	Carrots	50	70	40	30	20
1.5	Radishes	20	30	10	20	10
1.6	Leek	30	120	50	50	50
2	Maize	85	90	60	45	50
3	Wheat	80	110	70	60	40
4	Alfalfa	90	80	50	20	30
5	Clover	30	40	10	10	10
6	Potatoes	20	30	10	5	10
7	Beans	20	10	10	10	5
8	Oats	10	20	5	5	5
9	Fruit	40	30	15	10	15
10	Uncultivated land	15	40	10	5	5
	Total	720	1100	560	460	420

TABLE 3. Cropping pattern (ha) in study zone for year 2004.

NR		Shrigjan	Bradashesh	Jagodine	Bujqez	Kuqan
1	Vegetables	250	460	230	210	180
1.1	Spinach	20	60	20	10	10
1.2	Lettuce	30	80	40	40	30
1.3	Tomatoes	120	150	90	80	90
1.4	Carrots	40	60	30	30	10
1.5	Radishes	10	20	10	10	10
1.6	Leek	30	90	40	40	30
2	Maize	90	130	90	70	60
3	Wheat	100	140	100	90	85
4	Alfalfa	130	120	70	40	45
5	Clover	40	80	20	15	10
6	Potatoes	20	40	10	5	5
7	Beans	20	20	10	10	5
8	Oats	10	30	5	5	5
9	Fruit	45	50	15	10	20
10	Alyssum Murale	2	1	3	3	1
11	Uncultivated land	13	26	7	2	4
	Total	720	1100	560	460	420

TABLE 4. Estimated mean crops yields (kv/ha) comparing different technologies for the study zone during the period (2002–2004).

	Shirgjan		Bradashesh		Jagodine		Bujqëz		Kuqan	
	2002	2004	2002	2004	2002	2004	2002	2004	2002	2004
Wheat	36	42	30	35	35	40	32	34	36	38
Maize	56	60	50	52	55	65	48	56	56	62
Beans	15	18	14	15	17	21	16	18	15	19
Potatoes	110	115	90	105	110	130	95	115	90	100
Carrots	150	170	140	150	150	180	160	180	170	175
Tomatoes	300	320	290	295	310	350	310	340	315	330
Forage	400	410	360	380	400	450	390	410	380	390

those generated from cash crop cultivation, livestock still remains the main source of income for those farms that have no other choices due to their specific conditions as a result of soil contamination that makes the cultivation of vegetables and other cash crops impossible. Table 5 illustrates the trends in the livestock sector during the years 2002–2004. As can be seen a sharp increase has been recorded during the 2002–2004 period, when each farm

TABLE 5. The number and composition of livestock during the period 2002–2004.

	Shirgjan		Bradashesh		Jagodine		Bujqëz		Kuqan	
	2002	2004	2002	2004	2002	2004	2002	2004	2002	2004
Cows	480	650	950	1200	520	580	600	720	420	460
Oxen	20	15	40	60	10	12	20	25	10	15
Calves < 1 year	360	480	560	620	460	510	420	610	280	310
Calves > 1 year	280	350	380	390	350	360	320	420	210	290
Sheep	120	100	250	240	150	140	50	70	80	85
Goats	–	–	25	40	–	–	–	–	–	–
Poultry	3,000	4,500	8,500	9,200	4,500	4,800	5,000	5,600	4,500	5,200

tried to position itself within a changing economic environment by adopting risk-averse strategies. This trend is shown from an increased area cultivated with forage, such as alfalfa, clover, and other legumes. Those crops are able to grow and adapt very well in polluted soils and the "transfer factor" is low compared to vegetables and other crops. This farm structure creates possibilities to reduce adverse effects on the human population and to increase the quality of farmland and property values. Also, the use of such a farm structure will decrease the risk of pollution of the soil and groundwater, the contamination of urban areas, and public health problems. There was a notable variation in the farmers' evaluation of different technologies. Highlights from group discussions indicated that the criteria used to assess the pros and cons of improving soil quality through different remediation measures depends on the farmer's priorities, objectives and farm resources. The general consensus from group discussions was that the cultivation of forage, maize and wheat instead of vegetables such as lettuce, spinach, etc., can provide the same level of income and more importantly will decrease risks to health.

Field observations and group discussions evidenced an increase in the awareness of resource management concerns in the study zone. For example, the cultivation of *Alyssum murale* and other crops able to grow in contaminated soils increased even in sites where they traditionally were not cultivated before. A very important result of this project was that farmers and local authorities became convinced that they can limit soil contamination. Through tours to demonstration plots, we highlighted different plant species that limit heavy metals contamination. These field trips presented farmers and local officials with persuasive information about potential solutions to the problems that they faced. We also conveyed in our numerous meetings with farmers and local officials, that the primary source of soil and water pollution is man and his activities. We always offered modern, environmentally sound alternatives supported, in turn, by scientific data illustrating the viability of such methods. An extensive use of fito-remediation technologies needs well established technical support in the following areas:

- Support services to farmers to facilitate provision of initial technologies, seeds, and other inputs, training and on-farm demonstration
- An incentive framework for farmers, addressing major constraints associated with irrigation and drainage measures
- Production and delivery of effective training materials incorporating conservation as a part of good farming practices in order to transfer skills and simple methods to the end-users
- Ways to sensitize farmers and local authorities to environmental degradation as a yield loss and quality-of-life issue

5. Conclusions

The proposed development model, which combines the fito-remediation technologies with technical agricultural measures in areas with polluted soils, is fostered for areas with an agro-pastoral tradition, but which are ecologically unfit for intensive farming systems. The emphasis of the paper is therefore on the effectiveness and utility of the methodological approach. The major benefits would be the increase of the lifespan of main resources due to reduced soil contamination. An added, long-term benefit to the local communities, municipalities, and farmers will be the reduction of rural migration to the towns. We expect economic and environmental migration to decrease due to the increased fertility of soils and the general improvements in natural resources as a whole. We also expect to inform local and national legislators about the results of this project and request that they enact legislation supporting natural resource conservation and environmental clean-up. Our philosophy is that this initial pilot project is but the start of a long-term agro-environmental rehabilitation scheme. We believe it should begin with this pilot study and expand slowly as the ideas, concepts, and strategies are refined at increasingly larger levels of participation.

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ENVIRONMENTAL RISK ASSESSMENT OF A TEXTILE FACTORY IN TURKEY

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Abstract: Chemical explosion and fire risk assessment is conducted for a textile mill in Turkey. The study is within the framework of the first implementation of the EC Directive on Integrated Pollution Prevention and Control (IPPC Directive) (96/61/EC) before legal transposition of the directive. Carrying out risk assessments in industrial facilities is necessary to comply with IPPC. Industrial accidents should also be investigated within the framework of the Transboundary Effects of Industrial Accidents Directive (98/685/EC).

The study aims to conduct a semi-quantitative risk analysis for a textile mill. The prese.nt risk analysis focuses on risks arising from flammable and combustible chemicals. Accordingly, risky units and the associated risks are determined first. Then a suitable method for a semi-quantitative risk analysis is selected. To rank hazards in terms of risk levels, a matrix method is used. The highest risks turn out to be the knock-on effects of an explosion on other industrial facilities. The danger of a dust explosion and vapor cloud explosion occurring is ranked high as well. Overall a chemical warehouse possesses the highest risk level.

Keywords: Explosion, fire, industrial safety, environmental security, textile industry

1. Introduction

For industrial facilities posing potential hazards to the environment, residential areas or to other industrial facilities, carrying out risk assessments and preparing accident plans are indispensable. Assessing the hazards that the facility poses, trying to prevent or minimize them, and developing emergency plans are substantially important. Only via considering the environmental effects of industrial activities with an integrated approach can sustainable production be realized.

Industrial accidents due to hazardous materials are dangerous indeed for the environment and living organisms. There are several cases of industrial accidents which resulted in the deaths of thousands of people and animals with severe damage to various ecosystems. Human beings, animals, plants, aquatic systems, soil and atmosphere are vulnerable to accidents resulting from hazardous materials.

This study is carried out within the framework of the EU IPPC Directive of 1996. It is part of a project which aims to realize the first application of the Directive before legal transposition of IPPC into Turkish legislation. The IPPC Directive is an integrated directive which takes into account the environmental aspects of industrial activities as a whole, via the integration of environmental issues into production. The Directive emphasizes the importance of preventing accidents; hence risk assessments and accident plans for industrial facilities are necessary. There should be an accident plan for each industrial facility which should identify the hazards posed by the installation/activity, assess the risks associated with the installation, and set forth measures to be implemented to reduce the risks of accidents and contingency plans for any accidents that do occur. The Directive does not only consider accidents for which the effects are confined within the territory of the selected industrial facility, but it also emphasizes the importance of preventing knock-on effects of industrial activities on other facilities.

Industrial accidents should also be investigated within the framework of the EC Directive on Transboundary Effects of Industrial Accidents (98/685/EC). The explosion radius of an industrial accident may reach a neighboring country, potentially giving rise to an international incident. Hence, the probability of such an accident should be carefully examined and its possible effects mitigated. This Directive applies to industrial accidents capable of causing transboundary effects, including accidents caused by natural disasters. According to the Directive, appropriate measures should be taken to prevent industrial accidents. EU Member States should induce action by operators to reduce the risk of industrial accidents; establish policies on the siting of new hazardous activities and on significant modifications to existing hazardous activities with the objective of minimising the risk to the population and the environment; and prepare for emergencies caused by industrial accidents, introducing the necessary measures, including contingency plans, to prevent and minimise transboundary effects. This assessment is also vital for the Seveso Directives (Seveso I – 82/501/EC and Seveso II – 96/82/EC) and the Regulation on Control of Large Scale Industrial Accidents which is soon to be in force in Turkey.

An environmental risk assessment is conducted for a textile factory in Turkey. Due to the nature of its long and complex production chain, numerous chemicals are used during production including surfactants, dyes, pigments, chelating agents, and dispersing agents. In the textile mill where this study is carried out, about

130 chemicals are used. Most of them are stored within the main depository as well as the depositories of different departments in the facility. Chemicals are also transported and used inside the factory. In the present study, the probability of an explosion which involves these chemicals is examined.

1.1. TEXTILE MILL

The textile mill, which is said to be among the five largest in Europe, produces 20,000 t of cotton fiber and 40 million meters of denim fabric per year. The factory uses more than 130 different types of chemicals, many of which are hazardous.

There is another factory and an industrial zone which are both 20 m away from the factory. A residential area is approximately 350 m from the mill. Hence, any sort of industrial accident involving these chemicals may affect a large population. Also, when it is considered that another factory is situated near the textile factory and there is an industrial zone 20 m away from the facility, it can be said that a knock-on effect is likely to occur in case of an industrial accident. In other words, the effects of a probable accident may be larger because of a chain of accidental events.

The denim fabric production process starts with cotton in the integrated facility. First, different types of cotton are blended into fibers. By spinning fibers, yarn is produced. Yarns are dyed according to the color desired before weaving. Yarns should be strengthened to be weaved, otherwise they may easily detach. Hence, sizing is applied to yarns. During sizing, yarns are washed with a cellulose and amylase solution. Yarns which are stronger are then weaved. The finishing process is applied to give the desired quality and characteristics to the denim fabric. With the aid of numerous chemicals, resistance to creasing, shrinkage, and the effects of water and fire are given to the fabric. After the process shown in Figure 1, the denim fabric is ready for sale.
According to the site visit, some departments in the textile mill are found more risky in terms of chemical explosion and fire. These departments are:

- Main warehouse where chemicals are stored upon arrival

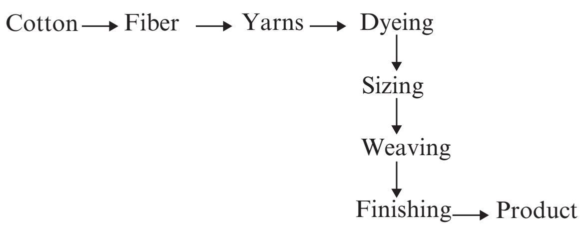

Figure 1. Process diagram of the facility.

- Small scale warehouses, color kitchens in dyeing, sizing and finishing departments

The risk analysis study focuses on these areas. The reason is that nearly 100% of the flammable and combustible chemicals used in the facility are stored, used and transported there. Out of 130 chemicals used, 47 of them are either flammable or combustible. Accordingly, 36% of the chemicals used in the facility carry the risk of causing chemical fires and explosions. The quantities of substances stored in the selected units are as follows:

Main warehouse: ~205,000 t/month

Dyeing: ~25,000 t/month

Sizing: ~90,000 t/month

Finishing: ~25,000 t/month

Approximately 345,000 t/month of flammable or combustible chemicals are stored, used and transported. Even though the textile mill works with the minimum stock principle, the production capacity is so large that preventing the storage of such an enormous mass of combustible and flammable chemicals is not possible. Hence, the resulting risk should be carefully analyzed.

Two major risks related to chemicals in this textile mill are vapor cloud explosion and dust explosion, according to the literature. Both of these explosions occur via similar mechanisms. First, flammable or combustible volatile chemicals evaporate forming a mixture with air. This mixture is a fuel for combustion.

2. Brief Description of Possible Explosion

In the following paragraphs, the literature is reviewed so as to understand the mechanisms of explosions resulting from chemicals. It is important to comprehend how a chemical can result in an explosion before assessing the risks associated with a particular chemical explosion hazard.

Vapor Cloud Explosion: Any liquid which is flammable may vaporize. The gas form of the substance develops a vapor cloud. The combination of the vapor cloud, oxygen and an ignition source is likely to result in fire or an explosion. A vapor cloud explosion may cause injuries and fatalities to humans and structural damage to buildings. The behavior of a vapor cloud explosion is very much like a gas explosion. Explosion occurs after vapor cloud formation in which enough flammable gas and oxidant are present to create the explosion. Thus, a vapor cloud explosion can be considered as a volumetric explosion with a possible propagation until the mixture is fully consumed (Alp, 2007a,b).

Dust Explosion: Most solid materials are combustible. The ease of combustion depends on the nature and dimensions of the solids. Finely divided solids burn more easily and they also burn more rapidly. The two main reasons are that access to oxygen is abundant in dust due to the increased surface area and heat cannot be withdrawn into the interior part of the burning body when this body is a small dust particle (Palmer, 1973).

The dust of combustible and some non-combustible materials is explosive to a certain degree. Grain dust, coal, wood flour, starch, sugar, cereals, and sulfur are known to be explosive. The factors to affect the likelihood of an explosion and its severity may be stated as the size of the dust particles, their moisture content, the quantity present, the size of the containing area and the size or temperature of the source of ignition (Underdown, 1979).

Expansion effects in dust explosions occur as a result of the heat produced during combustion. In addition, some gases are evolved from the dust due to high temperatures. A dust explosion should be considered as a spontaneous build-up of pressure or uncontrolled expansion effect (Palmer, 1973). The expansion effect of a dust explosion is eventually felt in the surroundings, causing damage.

The explosion usually occurs in two stages. First, a primary explosion shakes the building and creates dust. Then, a secondary explosion occurs with the effect of a blast wave. Secondary explosions are generally more destructive spreading throughout the facility.

For both of these phenomena to emerge, an ignition source should be introduced to the medium. Hot surfaces and sparks are the most frequent ignition sources in the industry. Contact with hot surfaces can give the substance a lag period before its temperature increases to ignition temperature. Sparks on the other hand can be produced by electricity, friction, or by welding (Palmer, 1973).

3. Approach

Within the scope of the risk assessment study, site visits to the facility were conducted several times. Some deficiencies and high risk conditions in the factory were detected. After that investigation, a detailed report about the current situation of the facility was prepared and reviewed with the participation of the heads of the facility. Some circumstances which were considered to carry an immediate high risk were brought to the attention of the factory management with proposals to resolve these items.

4. Common Semi-Quantitative Risk Assessment Techniques

Risk assessment can be conducted qualitatively, semi-quantitatively and quantitatively. In this study, only qualitative and semi-quantitative risk assessments are carried out. Detecting the deficiencies in the facility by a site visit is a means of constructing a qualitative risk assessment. Semi-quantitative risk assessment can be done by various methods.

A. Hazard and Operability studies (HAZOP)

HAZOP is an examination of the processes used in a facility to assess the hazard potentials that arise from deviations in design specifications and the consequential effects on the facility as a whole. It can identify and eliminate potential hazards and their effects at every stage of the project life cycle. Focusing on sensitive areas of the facility, HAZOP is suitable for chemical hazards (Alp, 2007b).
Advantages:

- It identifies and eliminates/mitigates potential hazards and their effects at every stage of production.
- The method focuses on the sensitive areas of the facility.

Disadvantages:

- It provides no numeric ranking of hazards.
- HAZOP focuses on one-event failures.
- It is time consuming.
- It requires an inter-disciplinary, skilled and experienced team (Alp, 2007b).

B. *Failure Mode & Effect Analysis*

Failure mode and effect analysis is a procedure by which each potential failure mode in a system is analyzed to determine its effect on the system and to classify it according to its degree of severity.
Advantages:

- The method is very structured and rigorous.

Disadvantages:

- Hazard ranking is not possible with this method.
- It is limited to identification of single failures; the method cannot integrate multiple causes.

C. Checklist Analysis

Checklist analysis is a list of items and questions to be answered yes or no. The preparation of questions and answers requires experience and knowledge about the facility.
Advantages:

- It is easy to use.
- It can be conducted quickly.

Disadvantages:

- It is limited by the experience and knowledge of the team.
- It yields a minimum level of hazard identification.
- It may not identify new hazards, but it is able to identify existing hazards.

D. What If Analysis

This method approaches the facility with a brainstorming mentality. Participants in risk assessments roam around the facility and repeatedly ask the question "What if" to see what could go wrong.

Advantages:

- It is easy to use.
- It works well for new & unusual scenarios.

Disadvantages:

- It is limited by the experience and knowledge of the participant.
- It is very unstructured and challenging to retain focus (Alp, 2007b).

E. Matrix Method

A risk assessment matrix is a simple way of ranking different risks of probable events in a facility. As soon as the frequency and consequences of the probable hazards are identified, the risk matrix can be formed as in Figure 2. Probable hazards are listed according to their frequency and consequences and are placed in a matrix. The top-right part of the matrix represents a higher severity of risk and the bottom-left part of the matrix represents a very low risk level.

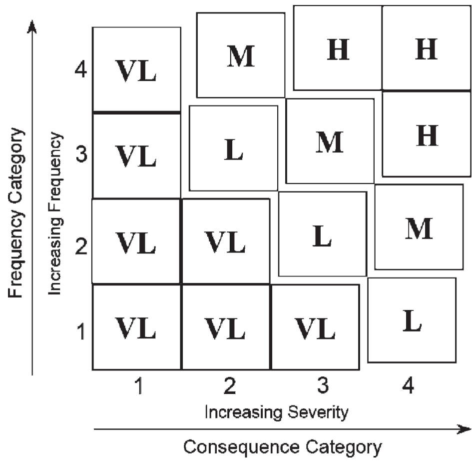

Figure 2. Risk Matrix example (Alp, 2007b).

Advantages:

- The matrix evaluation and ranking technique is a very powerful technique because it is simple and it can easily lead to decisions in terms of actions required immediately and further studies required for more detailed understanding.
- It is suitable to be used by everyone in the facility: operators, supervisors, management, engineering personnel, safety and environmental coordinators.
- The matrix approach mainly focuses on individual events, but also allows examination of the cumulative individual risk.

Disadvantages:

- If the definition of risk is not done properly, then the risk might either be overestimated or underestimated. It is very important to define risk in a correct way, when using this method.
- Consequences and the frequency of events should be examined carefully first, and then be integrated into this matrix (Alp, 2007b).

Among all of these methods, the matrix method was selected as it seemed to be the most advantageous. It gives the opportunity of hazard ranking and can prevent participant failures in risk assessment. The risk matrix is formed by the risk tables. Examples of risk tables which are formed for each risky unit can be seen in Tables 1 to 4. The determination of risk, which is very important in using this method, takes place after a literature review and interviews with facility employees.

5. Risk Matrices

Risks which are defined in risk tables are inserted in a risk matrix to apply the method. Examples of risk tables can be seen in Tables 1–4.

Examples of risk tables can be seen in Tables 1–4. However, they do not represent the whole risk table study. Overall, 48 risk items are investigated for this study: 12 risk items are written in risk tables for the main warehouse, 9 risk items for dyeing, 5 risk items for sizing and 22 risk items for finishing.

The risk items are then placed in a risk matrix where they are ranked in terms of their hazards. The risk matrix is in Figure 3.

In the matrix above, the risk level is determined with the aid of a risk equation (Risk = Frequency X Consequence). Risk which is expressed as a numerical value is inserted in different categories according to level. In the risk matrix, risk items are coded from risk tables. The numbers indicate the number of the action/situation in the risk table and the letters indicate the unit where the risk occurs.

5					
4				17-F	12-W
3			01-F, 02-F	09-D, 11-F	01-W, 02-W, 05-W, 10-W
2			06-D, 07-D, 05-F, 22-F	03-S, 01-D, 02-D, 03-D, 16-F, 04-F, 09-F, 14-F	03-W, 06-W, 08-W, 12-F, 13-F
1			04-D, 05-D, 06-F, 07-F, 10-F, 18-F	02-S, 04-S, 05-S, 08-D, 03-F, 08-F, 15-F, 19-F, 19-F, 20-F, 21-F	04-W, 07-W, 09-W, 11-W, 01-S
Frequence / Consequence	1	2	3	4	5

W: Warehouse, S: Sizing, D:Dyeing, F:Finishing

Very Low Risk Level	Low Risk Level	Medium Risk Level	High Risk Level

Figure 3. Chemical fire and explosion risk matrix of the selected textile mill.

Accordingly, the highest risk carrying items are determined to be:

- The explosion risk of tanks in the finishing section. A tank explosion could result in a blast wave to disturb starch dust and a dust explosion may occur.
- The probability of a knock-on effect on other industrial facilities in the case of an accident. If an accidental explosion occurs in the main warehouse, the scale of the explosion may enlarge spontaneously.

TABLE 1. Example of risk table for dyeing section.

#	Section	Action/situation	Risk	Current pre caution	A frequ ency 1–5	B Conse quence 1–5	Risk level A * B	Additional Precautions
01	Dyeing	Chemicals are not sorted according to their MSDS's	Vapor cloud explosion	None	1	3	3	Chemicals should be sorted according to their characteristics
02	Dyeing	Ventilation in chemical depot is lacking	Vapor cloud explosion	None	2	4	8	Adequate ventilation should be supplied
03	Dyeing	Dust cleaning is not done regularly	Dust explosion	None	1	4	4	Dust accumulation should be removed regularly

TABLE 2. Example of risk table for finishing section.

#	Section	Action/situation	Risk	Current precaution	A Frequ ency 1–5	B Conse quence 1–5	Risk level A * B	Additional precautions
………..		…..	…..	…..	…..	…..	…..	…..
17	Finishing	Pressurized reactors to prepare sizing solution are not tested frequently, in case of explosion, pressure can increase to form blast wave	Dust explosion	Not sufficient	4	4	16	Corroded reactors should be replaced and regular tests of reactors should be conducted. Also, removal of dust should be done regularly
………..		…..	…..	…..	…..	…..	…..	…..

- The risks of delay in appropriate measures or the implementation of inappropriate measures in the case of an accident, due to the absence of an emergency plan for the textile mill; in addition, any accidents that do occur may spread rapidly.

TABLE 3. Example of risk table for main warehouse (1)

#	Section	Action/ Situation	Risk	Current Precaution	A Frequency 1–5	B Consequence 1–5	Risk Level A*B	Additional Precautions
01	Main warehouse	There is no ventilation	Vapor cloud explosion	none	3	5	15	Adequate ventilation should be supplied
02	Main warehouse	Forklift or any electrical instrument inside the warehouse is not insulated / earthed	Vapor cloud explosion, dust explosion	none	3	5	15	Adequate ventilation and earthing electrical appliances
…..	…..	…..	…..	…..	…..	…..	…..	…..
05	Main warehouse	Flammable and combustible substances are not insulated inside the warehouse and the walls are not fire & explosion resistant	Scale of fires and explosions may enlarge spontaneously	not sufficient	3	5	15	Supplying isolation and fire & explosion resistant walls

TABLE 4. Example of risk table for main warehouse (2)

#	Section	Action/Situation	Risk	Current Precaution	A Frequency 1–5	B Consequence 1–5	Risk Level A*B	Additional Precautions
…..	…..	…..	…..	…..	…..	…..	…..	…..
10	Main warehouse	Appropriate interventions might not be realized in case of emergency	Scale of fires and explosions may enlarge spontaneously	not sufficient	3	5	15	Emergency plan should be prepared and employers should be trained
…..	…..	…..	…..	…..	…..	…..	…..	…..
12	Main warehouse	Main warehouse is only 20 meters away from cotton warehouse and other industries	Scale of fires and explosions may enlarge spontaneously and knock-on effect might be seen	none	4	5	20	Walls of the main warehouse should be fire and explosion resistant

- The risk of a vapor cloud explosion as there is not enough ventilation in the main warehouse. Any kind of flammable or combustible vapors remain inside for a long time and accumulate.
- The risk of a dust explosion or vapor cloud explosion as electrical appliances are not insulated. An ignition source may be introduced in the main warehouse in this way.
- The probability of enlargement in the scale of any accident that does occur, because the walls are not fire or explosion resistant in the main warehouse.

6. Conclusion

After this semi-quantitative risk assessment study, the highest risk carrying items and additional precautions are determined and conveyed to the facility management. These items are determined to be vapor cloud explosion, dust explosion and the knock-on influence of an industrial explosion on other industrial facilities. The highest risk level is observed in the chemical warehouse of the facility. This is closely pertinent to the location of the main warehouse and the amount of flammable and combustible materials stored inside the warehouse. Ungrounded electrical appliances, use of forklifts and the lack of ventilation in the main warehouse contributed to this result.

This study is important as it is the first implementation of a risk analysis for industrial accidents within the framework of the IPPC Directive. It is also substantial to show what sort of risks the facility may pose due to chemicals being stored and used in its processes.

To conclude, various chemicals located in industrial facilities may carry an enormous risk for the health of the public and the environment. Determining and diminishing this risk is very important for the sake of public health and environmental safety which is a requirement of the IPPC and Seveso Directives and the upcoming regulation on industrial accidents of Turkey.

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IPPC Directive 96/61/EC

Seveso I Directive – 82/501/EC and Seveso II Directive – 96/82/EC

AGENDA

NATO Advanced Research Workshop:
"Energy and Environmental Challenges to Security"

In conjunction with the NATO Parliamentary Assembly
Joint Sub-committee on Transatlantic Economic Relations (ESCTER) and Science and Technology Committee (STC)

The Hungarian Parliament
Budapest, 21–23 November 2007

Wednesday November 21
08.30: Registration and Seating of Participants

09.30: Opening Session

Welcome address by **H.E. Mrs. Katalin Szili**, Speaker of the Hungarian National Assembly

Opening remarks by **Mr. Attila Mesterhazy**, NATO Parliamentary Assembly, Hungarian Delegation, on behalf of the NATO Parliamentary Assembly

Opening remarks by **Mr. Ben Slay**, UNDP, on behalf of ENVSEC

Opening remarks by **Ms. Marta Szigeti Bonifert**, Executive Director of the Regional Environmental Center (REC), on behalf of the REC

Commencement of the ARW by co-directors **Dr. Besnik Baraj** and **Mr. Stephen Stec**

NATO OTAN This workshop is supported by: The NATO Science for Peace and Security Programme

10.30: Session I

POST-CONFLICT ENVIRONMENTAL CHALLENGES: Chaired by Mr. John Sewel, British MP and Chairman of the Sub-Committee on Transatlantic Economic Relations

Presentation on the impact of conflict and disaster on the environment, **Mr. Andrew Morton** (Programme Development Manager of UNEP's Post-conflict and Disaster Management Branch)

"Natural resources management in the absence of the rule of law: a case study from Bosnia and Herzegovina", **Ms. Lisa Tilney**, OSCE

Post-conflict environmental health risk: the role of risk analysis in foreign policy, **Mr. Chad Briggs**, Lehigh University and Institute for Environmental Security

Questions and Answers

12.30: Lunch (Outside the Delegation Hall)

14.00: Session II

TRANSBOUNDARY ENVIRONMENTAL CHALLENGES: Chaired by Dr. Besnik Baraj, University of Tirana (Albania), ARW Co-Director

Perspectives on nuclear safety in the Arctic, **Mr. Nils Bohmer**, the Bellona Foundation, Norway The

Questions and Answers

Multinational Approaches: A Tool for the Prevention and Reduction of the Risks of Nuclear Energy, **Mr. Anton Khlopkov**, Executive Director PIR Centre (Center for Policy Studies) Russia

Questions and Answers

Danube Basin, the Adriatic Sea Partnership, **Mr. Mitja Bricelj**, State Secretary, Ministry of the Environment and Spatial Planning of Slovenia

Questions and Answers

17.00–18.00: Reception hosted by Magyar Villamos Muvek Zrt. (outside the Delegation Hall)

19.00–20.30: Poster Session, Majorelle Room, Hotel Sofitel, Roosevelt ter 2

Posters

- Environmental Security: New Challenges for Comprehensive Security Strategies
  Dr. Barbara Haering, Switzerland
  Chair of the Committee on Security Policies of the National Council
  Econcept Inc. Zurich, Switzerland
- Regional Security and International Legal Regulation of Water Protection and Use (The Case of Serbia)
  Dr. Dragoljub Todic, Megatrend University, Belgrade, Serbia and
  Dr. Vid Vukasovic, Senior Research fellow, Belgrade, Serbia
- Power of the Central Asian Countries: Conditions, Problems, Prospects of Development and Cooperation
  Romen Zakhidov, Institute of Energy of Academy of Sciences of Uzbekistan
- Industrial Energetic Park of Vlora – Value or Damage
  Prof. Sazan Guri M.Sc., Marianthi Guri
- Energy and Environmental Security Challenges in South Eastern Europe through Implementation of Regional Treaty Establishing the Energy Community
  Prof Dr. Andjelka Mihajlov, Center for Environmental Engineering, Faculty of Technical Sciences, University of Novi Sad; City Public Health Institute, Beograd; Environmental Ambassadors
- Case study: Volga river basin, environmental issues, flood and migration
  Dr. Eva Csobod, REC, Country Office Hungary
- The EACH-FOR: Environmental Change and Forced Migration Scenarios
  Dr. Andras Vag, Research and Development of Atlas

Thursday November 22

09.00: **Session III**

THE INTERNATIONAL COMMUNITY'S APPROACH TO ENVIRONMENTAL SECURITY CHALLENGES: Chaired by Mr. Michael Mates, British MP and Chairman of the Science and Technology Committee

The ENVSEC Initiative, **Dr. James McQuaid**, member of the Environmental Security Advisory Panel, NATO; **Ms. Marta Szigeti Bonifert**, Executive Director, REC; **Mr. Bernard Snoy**, Co-ordinator of OSCE Economic and Environmental Activities

Questions and Answers

International Organisations' Co-operation around Environmental Security, **Ms. Fiona Borthwick**, Central European University, Hungary

Questions and Answers

12:30: **Lunch (Outside the Delegation Hall)**

14.00 **SESSION IV**

TRANSATLANTIC ENERGY SECURITY – Key Issues: Chaired by Ambassador Istvan Gyarmati, Director of the International Centre for Democratic Transition, Hungary

European dependence on Russian gas – energy sources as political levers, implications of the German pipeline deal, **Ambassador Istvan Gyarmati**

Questions and Answers

The Union's Energy Policy: A European Security Challenge, **Ms. Edit Herczog**, member of the European Parliament

Questions and Answers

Dependence on Middle East energy and its impact on global security, **Dr. Gal Luft**, Executive Director of the Institute for the Analysis of Global Security

Questions and Answers

Can energy technologies provide energy security and climate change mitigation? **Professor Ralph Sims**, International Energy Agency, Paris

Questions and Answers

17.00: **Close of Second Day**

19.30: **Reception Hosted by the Ministry of Defence of Hungary, Stefania Palace and Cultural Centre**

Friday November 23

09.00: **SESSION V**

CLIMATE CHANGE: Chaired by Mr. Stephen Stec, REC, Leiden University, Central European University, ARW Co-Director

Scientific evidence and what the latest models predict, **Mr. Elliot Morley**, member of UK Parliament, Government's Special Representative on the Gleneagles Dialogue on Climate Change, Clean Energy and Sustainability

Kyoto and beyond: Can Europe and the United States find common ground on meeting the challenge: update on recent transatlantic discussions, **Ambassador April H. Foley**, US Ambassador to Hungary

Questions and Answers

11.00: **KEYNOTE PRESENTATION**

Professor Norman Myers, Oxford University, Duke University: Sources of Environmental Security Concerns

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12.15: **CLOSING STATEMENT**
Ms. Agnes Vadai, Secretary of State for Defence Ministry, Hungary

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End of Programme

Afternoon Optional informal meetings among parliamentarians, scientists and experts

Presentations and posters are available on the ARW website – www.rec.org/nato workshop

LIST OF ABBREVIATIONS

μSv/h	Microsieverts per hour
AAU	Assigned Amount Unit
APERC	Asia-Pacific Energy Research Centre
ARW	Advanced Research Workshop
ASI	Advanced Study Institute
ATC	Advanced Training Course
bbl/d	Barrels per day
bcf	Billion cubic feet
bcm	Billion cubic meters
BFBC	Fluidized Bed Combustion in Both Bubbling
BiH	Bosnia and Herzegovina
bkw	Billion kilowatts
bkwh	Billion kilowatt hours
BTC	Baku-Tbilisi-Ceyhan pipeline
BTU	British Thermal Units
C and R	Clean and Renewables
CAC	Central Asia–Central pipeline
CBP	Chemical/Biological/Physics
CBRN	Chemical/Biological/Radiological/Nuclear
CCGT	Combined Cycle Gas Turbine
CCMS	Committee on the Challenges of Modern Society
CCS	Carbon dioxide Capture and Storage
CDM	Clean Development Mechanism project
CENTCOM	United States Central Command
CFB	Circulated Fluidized Bed
CH_4	Methane
CHP	Combined Heat and Power
CITES	Convention on International Trade in Endangered Species of Wild Flora and Fauna
CLG	Collaborative Linkage Grant
CMEA	Council for Mutual Economic Assistance
CO_2	Carbon dioxide
CPC	Caspian Pipeline Consortium
CRED	Center for Research on the Epidemiology of Disasters
CSCE	Conference on Security and Cooperation in Europe
CSIS	Centre for Strategic and International Studies
CSP	Concentrating solar power
CSWS	Coal Slurry-Water Suspension
DU	Depleted Uranium
EBRD	European Bank for Reconstruction and Development
EC	European Commission
ECACP	Environmental Change and Acute Conflict Project

ECT	Energy Community Treaty
EE	Energy Efficiency
EIA	Environmental Impact Assessment
EIT	Economies In Transition
ENCOP	Environment and Conflicts Project
EnEnSEC	Environmental-Energy Security
ENVSEC	Environment and Security Initiative
EPA	Environmental Protection Agency
ERU	Emissions Reduction Unit
ES	Environmental Security
ESPO	Eastern Siberia Pacific Ocean pipeline
EU	European Union
EU ETS	European Union Emissions Trading Scheme
EUFOR	European Union Military Force
EurAsEC	Eurasian Economic Community
FBB	Fluidized Bubbling Bed
FBC	Fluidized Bed Combustion
FEED	Front-End Engineering and Design
FMEA	Failure Mode and Effect Analysis
FNC	First National Communication
GDP	Gross Domestic Product
GECF	Gas Exporting Countries Forum
GECHS	Global Environmental Change and Human Security
GEF	Global Environmental Facilities
GHG	Greenhouse Gas
GIS	Green Investment Scheme
GNEP	Global Nuclear Energy Partnership
GTL	Gas-To-Liquids
GW	Gigawatt
GWe	Gigawatt electric
HAZOP	Hazard and Operability Studies
HDI	Human Development Indicators
HDR	Human Development Report
HPP	Hydropower Plant
HSD	Human and Societal Dynamics
IAEA	International Atomic Energy Agency
ICI	Istanbul Cooperation Initiative
ICS	Information and Communications Security
IDP	Internally Displaced Person
IEA	International Energy Agency
IEF	International Energy Forum
IES	Institute for Environmental Security
IGCC	Integrated gasification combined cycle
IMF	International Monetary Fund
IOM	International Organization for Migration
IPCC	Intergovernmental Panel on Climate Change

IPPC	Integrated Pollution Prevention and Control Directive
IPSA	Iraqi Pipeline through Saudi Arabia
IRC	International Red Cross
IUEC	International Uranium Enrichment Center
JI	Joint Implementation
KCTS	Kazakhstan Caspian Transportation System
KEK	Kosovo Energetic Corporation/Korporata Energjetike e Kosovës
kWh	Kilowatt hour
LCP	Large combustion Plant
LEAP	Long Range Energy Alternatives Planning System
LHV	Low Heat Value
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LS	Sodium Lignosulfonate
MAGICC	Model for the Assessment of Greenhouse-gas Induced Climate Change
mb/d	Million barrels per day
MDG	Millennium Development Goal
MEFWA	Ministry of Environment, Forests & Water Administration
MoU	Memorandum of Understanding
MO_X	Mixed oxide fuel
MRC	Mati River Cascade
MRCA	Mati River Catchment Area
Mtce	Million tonnes of coal equivalent
Mtoe	Million tonnes of oil equivalent
MW	Megawatt
MWe	Megawatt electrical
NATO	North Atlantic Treaty Organization
NC	National Communication
NEK	Natsionalna Elektricheska Kompania
NFC	Nuclear Fuel Cycle
NGCC	Natural Gas Combined Cycle
NGO	Nongovernmental Organization
NIG	Networking Infrastructure Grant
NO_x	Nitrogen oxide
NPP	Nuclear Power Plant
NSDI	National Strategy for Development and Integration
OAO	Open joint stock company
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
OSCE	Organization for Security and Co-operation in Europe
PA	Privatization Agency
PCC	Pulverized Coal Combustion
PFBC	Pressurized Fluidized Bed Combustion
PKK	Kurdistan Workers' Party
PLO	Palestine Liberation Organization

PPCC	Pressurized Pulverized Combustion of Coal
PV	Photovoltaic energy
R & D	Research and development
RD^3	Development research, development, demonstration and deployment
RDF	Rapid Deployment Force
REC	Regional Environmental Center
REF	Renewable Energy Facility
REM	Regional Electricity Market
RNFCC	Regional Nuclear Fuel Cycle Centers
SAA	Stabilization and Association Agreement
SCP	South Caucasus Pipeline
SCR	Selective Catalytic Reactor
SEE	South East Europe
SfP	Science for Peace
SHP/SHPP	Small Hydropower Plant
SIDA	Swedish International Development Agency
SNC	Second National Communication
SNF	Spent Nuclear Fuel
SO_2	Sulfur dioxide
SPR	Strategic Petroleum Reserve
SPS	Science for Peace and Security
StS	Security through Science
TAP	Trans Alpine Pipeline
TAR	3rd Assessment Report
TCGP	Trans Caspian Gas Pipeline
TNA	Technology Needs Assessment
TPP	Thermo Power Plant
TS	Technological Systems
TWh	Terawatt-hours
UAE	United Arab Emirates
UK	United Kingdom
UN	United Nations
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNMIK	United Nations Mission in Kosovo
US/USA	United States of America
USAID	United States Agency for International Development
USGS	United States Geological Survey
UTB	Universal Terminal Bourgas
Wh	Watts per hour
WHO	World Health Organization
WMD	Weapons of Mass Destruction
WTO	World Trade Organization

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