NATO Science for Peace and Security Series - C:
Environmental Security

# Water Scarcity, Land Degradation and Desertification in the Mediterranean Region

## Environmental and Security Aspects

Edited by
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# Water Scarcity, Land Degradation and Desertification in the Mediterranean Region

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**Series C: Environmental Security**

# Water Scarcity, Land Degradation and Desertification in the Mediterranean Region

Environmental and Security Aspects

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# Executive Summary

Based on the suggestions made by the speakers of Plenary Session IV "Challenges to the management of water resources and to countering desertification in the Mediterranean region" during the 15th Economic and Environmental Forum, the OCEEA proposed to organize a workshop on "Water Scarcity, Land Degradation and Desertification in the Mediterranean region – Environment and Security Aspects".

In order to build on common synergies, OSCE sought co-operation with colleagues from NATO, in particular from the Science for Peace and Security Programme. NATO has a longstanding expertise on the issue and had organised in Valencia, in December 2003, a NATO scientific workshop on "Desertification and Security in the Mediterranean Region". The objective of the new proposed workshop would be to broaden its focus from the scientific community to include also policy makers.

The workshop, aimed at government officials from the Mediterranean Region,[1] gathered representatives of Water management, Land degradation and Desertification Departments of Ministries of Environment and representatives from the Ministries of Foreign Affairs. In addition, policy makers, scientists and experts were also invited. The aim was to discuss how the OSCE, NATO and other competent organizations like the UNCCD, UNEP, MAP, and the EU could play a role in ensuring that environment and security linkages in terms of water scarcity, land degradation and desertification are addressed in the Mediterranean Region.

The workshop was structured in three Plenary Sessions, with keynote speakers, and four Working Groups to facilitate the dialogue and exchange of ideas between the participants on the different key topics.

A total of 65 participants from 19 different countries attended the workshop, contributing with their ideas and experience to its success, reflected in the large number of specific recommendations for the OSCE and NATO.

[1] The document uses a restrictive notion of the Mediterranean region, limited to the OSCE Mediterranean Partners for Co-operation (Algeria, Egypt, Israel, Jordan, Morocco and Tunisia) and the NATO Mediterranean dialogue (all the OSCE Mediterranean partners, plus Mauritania).

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Among the recommendations, the importance of implementing a survey and/or an assessment on water scarcity, land degradation, desertification and security in the Mediterranean Region, was underlined by many participants. An international initiative at this level could be implemented, according to example of the ENVSEC initiative which aims at addressing environmental risks to security and fostering stability through environmental co-operation.

As a conclusion, participants agreed that the synergies between scientitss and diplomats and the intense brainstorming regarding different issues resulted in a fruitful debate producing valuable ideas and possible initiatives for a near future. Another conclusion is that the advance in a North–South Mediterranean co-operation with a maintained dialogue between countries can be the best, and perharps, the only way to assure sustainability and security of the whole region.

# Introduction

Water scarcity, land degradation and desertification are factors which have direct negative consequences on the general status of the ecosystem affected by these phenomena and on the people who live in the same ecosystem. The decrease of available resources, the competition to get access to them, the social and political instability and migration, are also consequences of a degraded environment and are directly related to the security of populations.

Essentially, this is the rationale on which NATO and OSCE decided to organise the workshop held in Valencia on 10 and 11 December 2007. The challenge was to gather scientists, experts and policy makers from different countries to analyse the environmental conditions of the Mediterranean region; to discuss the security aspects of water management and land use; to assess the loss of livelihoods and to identify means of combating land degradation and to prevent possible conflicts.

The organizers of the workshop never presumed to examine exhaustively the issues related to the topics discussed at the meeting. However, NATO and OSCE played an important positive role by providing a forum of discussion for representatives of different institutions. By doing so, a first important result was achieved: to increase the awareness of issues such as land degradation and desertification in the Mediterranean Region as a potential risk to social and political stability.

The presentations at the general sessions were qualified and detailed; the discussions in the working groups were lively and practically oriented. Many items were put forward for further consideration by the experts and the policy makers such as:

- The analysis of case studies in the Mediterranean region
- The identification of best practices
- The launch of pilot projects for land remediation
- The establishment of national information centers on land degradation and desertification
- The environment security assessment for the Mediterranean Basin

The debate and the activities on the above-mentioned topics should involve other international organizations besides OSCE and NATO and it is urgent to increase the dialogue between the concerned countries in the Mediterranean Basin.

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The existence of national plans to counter environmental degradation and desertification was noted and the importance was stressed of an increased collaboration across political boundaries. Here there is again a potential role for international organizations which could serve as platforms for trans-national collaboration.

Some important issues were only approached in a preliminary way and need further discussion such as:

- Evaluating to what extent improper water and land management affects populations in a way that reduces their security and also may lead to conflicts within the community (these conflicts may concern a large segment of the population and may even cross political boundaries, thus affecting regional political stability).
- Better defining the concept of "Environment Security". As a matter of fact, scientists and policy makers do not always have the same perception of this concept. Consequently future meetings and analysis should be more related to specific cases in which land degradation and desertification have shown to be unequivocally as drivers of security loss.

The recommendations and the concepts elaborated during the two-day workshop will be brought to the attention of the National Representatives in NATO and in OSCE and will also be a contribution to an expanded security concept, which should be tackled from different angles, both at the national and at the international level, for elaborating integrated strategies.

OSCE and NATO, together with the UNCCD, played a pioneering role in this respect. In a more practical term, such collaboration could be further implemented by launching in the Mediterranean Region a cooperative partnership such as the ENVSEC initiative (in which UNDP, UNEP, UNECE, REC, OSCE and NATO are working together) aimed at addressing environmental risks to security and at fostering stability through environmental cooperation.

F. Pedrazzini and R. Daussa

# Background Paper

**Raul Daussa**

## Introduction

The Mediterranean region has been identified as one of the most vulnerable areas in terms of environment and security linkages. Due to its climatic and topographic features, as well as the cross-boundary dimension of the Mediterranean Basin, intermixed with cultural, political and economic diversity, the region represents an area that poses potential for social and political instability, with repercussions for the whole OSCE region, in particular for Europe.

Since its establishment, the OSCE has maintained special relations with its six Mediterranean Partners for Co-operation: Algeria, Egypt, Israel, Jordan, Morocco and Tunisia. The grounds were established in the Helsinki Final Act that included a chapter on questions relating to security and co-operation in the Mediterranean, highlighting the interlinkages between the OSCE region and its Partners for Co-operation. NATO also includes Mauritania in its Mediterranean Dialogue.

With this in mind, and with a view to enhance the political dialogue and co-operation on combating environmental challenges in the Mediterranean region among OSCE participating states and Mediterranean Partners for Co-operation, Plenary Session IV of the 2nd part of the 15th OSCE Economic and Environmental Forum was devoted to discussing "Challenges to the management of water resources and to countering desertification in the Mediterranean region". The session gave an overview of the challenges of sustainable water and land management in the region and presented some best-practices in addressing the issue.

The speakers of the session concluded that the OSCE, in co-operation with other relevant international organizations, NATO in this case, had a role to play in countering desertification and unsustainable management of water resources. They recommended that the Office of the OSCE Co-ordinator on Economic and Environmental Activities (OCEEA) could facilitate a workshop to bring experts together

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to discuss these issues and begin to co-ordinate institutional actions addressing the existing challenges.

## Background

### *The Environmental Vulnerability of the Mediterranean Region*

The Mediterranean region is a highly vulnerable area. Extreme weather events which are likely to increase under the warming trend will have severe implications on desertification, land degradation, and water availability.

Due to its geographical position, great parts of the Mediterranean region have an arid, semi-arid and dry-sub humid climate and subject to seasonable droughts and seasonable rainfalls. Hence, the sustainable use and management of land and water resources is of particular importance. The Report of Stockholm International Water Institute mentions that "Continued water scarcities will affect the Region's social and economic potential, increase land vulnerability to salinisation and desertification and raise the risk for potential conflict around the limited water available."[1]

Further pressure on the Region's natural resources stem from rapid population growth. The concentration of great parts of the population in small territories that are fertile and where main economic activities are located, such as in coastal areas, often lead to overexploitation of land and water resources in these areas. The availability of fresh water resources is steadily decreasing as population grows, thus urgently calls for new governance patterns.

Irrigated agriculture, currently responsible for about two-thirds of the water consumption in the Mediterranean region, further increases the demand for water resources. Furthermore, poor agriculture practices and unsustainable management of land contributed to deforestation, soil erosion, biodiversity loss and decrease of soil fertility.

In brief, due to a series of natural hazards the Mediterranean region's natural resources are particular vulnerable. Hence, there is a pressing need for finding ways of sustainable use and management of the vital land and water resources, in order to reduce negative human impacts and to prevent conflicts for scarce resources and enable human development in the region.

### *Good Governance as Key for Dealing with Scarce Resources*

Human activities may increase the vulnerability of natural resources. Therefore, good governance of scarce resources is a key to ensure sustainability, especially

[1] Water Scarcity Challenges in the Middle East and North Africa (MENA) – Human Development Report Office, Occasional Paper, 2006, by Håkan Tropp and Anders Jäkerskog, Stockholm International Water Institute (SIWI).

in regard to allocation, in order to prevent conflicts between states and also between the relevant stakeholders within states.

Good governance is based on transparent processes, open access to information and the involvement of all relevant stakeholders in decision-making processes. Sound legal and institutional arrangements need to be put in place in order to ensure that decision-making systems are responsive to the existing challenges.

UNDP defines water governance as encompassing "Political, economic and social processes and institutions by governments, civil society and the private sector to make decisions about how best to use, develop and manage water resources."[2]

Thus, improving the governance of natural resources may not only contribute to sustainable development but will also positively influence the stability of societies and strengthen institutions and their legitimacy.

## Definitions

### *Environmental Security*

For the purpose of this paper, Environmental Security refers to the impact of environmental factors on security. These environmental factors include both natural environmental phenomena, such as natural disasters, and environmental changes caused by human activity such as depletion of natural resources, loss of biodiversity and climate change. The impact of human activity on the environment can, however also be positive and depends on the quality of governance as it applies, among others, to the use and management of natural resources.

### *Desertification and Land Degradation*[3]

Desertification means the land degradation in arid, semi-arid and dry-sub humid areas. Land is the terrestrial bio-productive system that comprises soil, vegetation, other biota, and the ecological and hydrological processes. Land degradation means

[2] United Nations Development Programme (UNDP) 2004, Water Governance for Poverty Reduction. Key Issues and the UNDP Response to Millennium Development Goals, New York, 10.

[3] Desertification is defined by the UNCCD as land degradation in the drylands, and further explains that land degradation is reduction of biological or economic productivity in the various land uses (e.g. rangelands, croplands, etc.). The Millennium Ecosystem Assessment further elaborated on this definition, stating that desertification is a persistent reduction in productivity. It should be noted that land degradation occurs not only in Mediterranean drylands but also in humid areas in the Mediterranean region, thus when the term "desertification" is used, this applies only to drylands; when "land degradation" is used, this applies to all regions, and when the two of them are jointly used, this it to emphasize addressing to land degradation in both drylands and non-dryland areas.

loss of the biological and economic productivity of rainfed or irrigated cropland, or range pasture, forests and woodlands resulting from various factors, including climatic variations and human activities such as unsustainable land uses.

## Annotated Agenda for the Workshop

### *Opening Plenary*

Following the welcoming of the participants by the OSCE Chairmanship, the agenda of the workshop will be presented, reiterating the objectives, methodology, and organization modalities of the working groups.

### *Plenary Session I*

**Environmental Conditions in the Mediterranean Region. Possible Future Scenarios Followed by Discussion**

The purpose of Plenary Session I is to gain better insights on specific conditions in the Mediterranean region in terms of climate and topography, as well as the cross-boundary dimension of the Mediterranean Basin and their implications on environment and security.

### *Plenary Session II*

**Reviewing Environment and Security Linkages**

Against the background of the specific conditions of the Mediterranean region, as presented in the previous Session, the challenges of land degradation and water scarcity in the region and implications on national, regional and international security shall be reviewed.

Emphasis will be placed on how human activities contribute to further degradation of land (high concentration of industry, poor agriculture practices, rapid urbanisation, and unsustainable tourism policies).

## *Working Groups*

Building on the preceding presentations and discussions, the plenary will be divided in two working groups, in order to explore the most pressing threats in the region in more detail.

The Working Group session will end with a plenary reporting session where each Working Group facilitator will summarise the key conclusions of the Working Group sessions, including recommendations on how the particular challenges can be addressed in the most effective and efficient manner.

- WG I – Security implications of unsustainable water management and land use

The rapid expansion of urban areas leads to the loss of natural and agriculture spaces. Especially, coastal regions represent an area for diverse economic activities. The growing transport, tourism and industrial infrastructure in coastal areas also lead to increased pressure on, and degradation of natural resources. In order to tackle these challenges, there is an urgent need for improved town planning and in particular for diversifying economic activities and tourism policies.

- WG II – Loss of livelihoods and increased migration

Due to its climatic and topographic conditions, some areas of the Mediterranean region do not provide optimal conditions for productive agriculture. Overgrazing and over-tilling leads to further depletion and degradation of natural resources and often result in an increased number of economic and environmental induced migrants within countries, from rural to urban regions, but also between states. The resulting increase in the population density often leads to un-managed urban expansion and puts further pressure on urban infrastructure, in particular in terms of waste management, water supply and transport, hence to intensified competition for resources. On the other hand, the increasing migration flows to urban area leads to abandoned agriculture lands.

The main issue to be discussed in this session will be the challenge to identify in how far environmental factors can be identified as one of the main causes for migration in the Mediterranean region. A key research project on this subject will be briefly presented by the facilitator: "Environmental Change and Forced Migration Scenarios" (EACH-FOR). EACH-FOR is a research project within the frames of FP6 of the European Commission. The project will produce detailed sub-region or country level forced migration scenarios, including environmentally induced migrants; presentation of causes leading to forced migration, with focus on environmental concerns; and an online running "environment degradation caused forced migration" simulation model for demonstration and policy purposes.

## *Plenary Session III*

Improving land-use planning schemes and the management of water resources and soil require necessary institutional and participative mechanisms that provide for

the better use of existing scarce and fragile resources and the sustainable allocation of water resources between competing sectors. Transparent decision-making processes and active participation of users and other stakeholders is crucial for creating a framework for the sustainable use of natural resources.

Presentations of best practices from the Mediterranean region will illustrate how to address challenges of good governance with regard to land and water resources at national, regional and international level, in order to ensure the sustainable use of the existing scarce natural resources.

## *Working Groups*

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The Working Group session will end with a plenary reporting session where each Working Group facilitator will summarise the key conclusions of the Working Group sessions, including recommendations on how the particular challenges can be addressed in the most effective and efficient manner.

- WG III – Linkages between combating land degradation, desertification and conflict prevention

Being subject to extreme climate conditions, population densities, heavy concentration and intensive agriculture, soil in the Mediterranean region is particularly prone to degradation and desertification. As soil degradation and desertification may contribute to scarcity of water and vice versa, combating land degradation requires an integrated approach that takes into account water management and also addresses agricultural and industrial issues. Being a common threat in the region, land degradation calls for transboundary solutions. Land degradation/desertification/drought and their associated impacts constitute a clear, growing and global threat to economic sustainability, social cohesion and public security.

Sound governance in land management as well as rehabilitation of degraded land require a participatory approach including all relevant stakeholders, transparent decision-making processes as well as the accountability of governmental institutions. Appropriate management of land could lead to a sustainable use of the land and thus prevent the exacerbation of poverty and the negative impact on social order and stability.

- WG IV – Managing water scarcity

In this Working Group participants will explore water scarcity due to both quantities and qualities, and the need for sound management practices. Water scarcity due to climate variability and increasing demand for water can be a source of conflict, but on the other hand, it can also trigger cooperation. Examples and best practices on water management co-operation will be discussed. Finally, water scarcity can be alleviated by creating new sources of water: Recycling of wastewater and water desalination.

### *Closing Plenary*

**The Role of the OSCE and NATO, and Other Competent Organizations in Raising Awareness About Environment and Security Linkages in the Mediterranean Region**

This session will discuss the role of the OSCE and NATO in raising awareness about environment and security linkages in the Mediterranean, based on both organizations' mandate and capacities and considering the existing initiatives in this area. The purpose is to discuss possible follow-up activities, taking into account the recommendations reached at the workshop.

- Replicating the model of Public Environmental Information Centres in the Mediterranean Region
- Supporting governments in creating incentives for promoting the development and use of new technologies
- Capitalising on best practice experience and stimulating political will at the highest level

## Background Information on the OCEEA and NATO Science for Peace and Security Programme

### *The OSCE Co-ordinator of Economic and Environmental Activities*

Although not primarily an economic organization, the OSCE is involved in economic and environmental activities, operating on the premise that promoting economic prosperity and co-operating on environmental problems can contribute to the enhancement of international security and stability.

The OSCE promotes a continuous dialogue through regular meetings of its permanent bodies in Vienna such as the Permanent Council, and the Economic and Environmental Committee. Economic and environmental officers operate on the ground in the OSCE Field Presences in South-Eastern Europe, Eastern Europe, the Caucasus and Central Asia.

The Co-ordinator of OSCE Economic and Environmental Activities, acting in support of the Chairman-in-Office, is charged with strengthening the ability of the Permanent Council and the OSCE institutions to address economic, social and environmental aspects of security.

The Co-ordinator's regular priorities are

- To enhance the OSCE's interaction with relevant international organizations
- To strengthen the economic, environmental, and social components in the work of OSCE missions and field activities
- To deepen interaction with the OSCE Parliamentary Assembly

- To broaden OSCE contacts with non-governmental organizations and the private sector
- To formulate a programme of work for appropriate additional activities in, and relating to the OSCE's economic dimension

The Co-ordinator, who works under the direct supervision of the Secretary General, is assisted by an office staff of 16 persons. (More information on www.osce.org/eea.)

## *OSCE Mediterranean Partners for Co-operation*

The OSCE maintains special relations with six Mediterranean Partners for Co-operation: Algeria, Egypt, Israel, Jordan, Morocco and Tunisia.

This relationship goes back to the Helsinki Process and the Helsinki Final Act, which included a Mediterranean chapter stating that security in Europe is closely linked with security in the Mediterranean as a whole. This inter-linkage has been underscored in subsequent CSCE/OSCE documents, such as the Istanbul Charter for European Security and the Maastricht OSCE Strategy to Address Threats to Security and Stability in the 21st century. Permanent Council decision 571 decided to explore new avenues of co-operation and interaction and to explore the scope for wider sharing of OSCE norms, principles and commitments.

Over the years, the OSCE has been able to share its experience with the Mediterranean Partners for Co-operation on a number of topics, including OSCE economic and environmental dimension commitments. Through ongoing dialogue and joint activities with the Mediterranean Partners for Co-operation, the OSCE shares its expertise and provides insight into current developments and is open to reciprocal enrichment provided by them.

## *The NATO Science for Peace and Security Programme*

The *Science for Peace and Security (SPS) Programme* sponsors practical cooperation between scientists from NATO member, Partner and Mediterranean Dialogue countries on security-related issues in the fields of civil science, environment and technology. The programme seeks to develop recommendations and solutions for a variety of problems in these fields, as well as to respond to the needs of partner countries. Overall the aim is to contribute to security, stability and solidarity among NATO Partnership for Peace as well as Mediterranean Dialogue nations, by facilitating collaboration, networking and capacity-building, while promoting the application of the best technical expertise to problem solving. The SPS Programme is overseen by a specific Committee, which is subordinate to the North Atlantic Council and also advises the Council and other NATO bodies on security-related civil scientific, environmental and technological issues.

The SPS Programme offers grants for collaboration between scientists in NATO member states and countries which are associated with NATO through the Euro-Atlantic Partnership Council and through the Mediterranean Dialogue. Activities consist of workshops, training courses, exchange of experts and longer-duration projects, which lead not only to the formulation of specific recommendations but also to tangible products, capacity – building and the creation of international networks of scientists. Staff support for the SPS Committee is provided by a secretariat in NATO's Public Diplomacy Division, under the direction of the Assistant Secretary General for Public Diplomacy.

### *The NATO Mediterranean Dialogue*

The NATO Mediterranean Dialogue is primarily bilateral in structure (NATO + 1) but allows also for multilateral meetings on a regular basis. (NATO + 7: Algeria, Egypt, Israel, Jordan, Mauritania, Morocco and Tunisia). The Dialogue consists of a political dialogue combined with participation in specific activities, aimed at exchanging views and information related to the security situation in the Mediterranean region in order to improve regional security and stability. In addition to political meetings, there are regularly organized seminars, workshops and other practical activities in the fields of public information, press activities, and other activities to promote scientific and environmental cooperation.

For example, the workshop "Desertification in the Mediterranean Region. A Security Issue" organized in Valencia, Spain in December 2003 under the auspices of the NATO Security through Science Programme. (More information on http://www.nato.int/med-dial/home.htm.)

## Other International Organizations and Related Initiatives

Several other initiatives are in place which could benefit from the increased OSCE activities in the Mediterranean region.

### *The UN Convention to Combat Desertification (UNCCD)*

Several Articles of the Convention and two of the Annexes of Regional Application (Annex I for Africa and Annex IV for Northern Mediterranean) are of particular importance for the Mediterranean region as they call for cooperation between all levels of government, communities, NGOs, land users and international partnership. The objective is to promote sustainable development, better understanding of the value of land resources and scarce water resources, and to ensure sustainable policy planning and decision making through the implementation of national action programmes to combat desertification and land degradation thus contributing to poverty

reduction. Action programmes at sub regional and regional level, complement and increase the efficiency of national programmes, particularly in the management of transboundary natural resources. The UNCCD Secretariat provides assistance to all affected countries, particularly those in Africa, in, among others, compiling information and reports required under the convention. (More information on http://www.unccd.int.)

## *UNEP/Mediterranean Action Plan (MAP)/"Barcelona Convention"*

The Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean and its six protocols constitute the Mediterranean Action Plan's (MAP) Legal Framework which aims at reducing pollution in the Mediterranean Sea and protect and improve the marine environment in the area, thereby contributing to its sustainable development.

## *The Euro-Mediterranean Partnership/Barcelona Process*

The Barcelona Process was launched in 1995 and provides a wide framework of political, economic, and social relations between the EU and Partners of the South Mediterranean.

In the framework of the Euro-Mediterranean Partnership, adopted in Barcelona in 1995, the European Union established the 'Short and Medium-Term Priority Environmental Action Programme' (SMAP). This was intended to be the operational tool for the implementation of policy adopted by Euro-Mediterranean partners in the environmental area. It should also provide project financing from the Regional Environment Programme of the MEDA financing instrument.

In addition to the regional component, the EU has concluded bilateral association agreements with most of its partner countries under the framework of the EMP. Through these agreements, the EU and its partner countries agree to work towards legislative approximation and cooperation in a wide range of sectors, including environment.

### European Neighbourhood Policy

In addition to the Barcelona Process, in the framework of the European Neighbourhood Policy (ENP) countries need to prepare *Strategy Papers,* defining the principles, geographical scope, methodology for implementation of the ENP and issues related to regional co-operation. *Country Reports* cover progress in implementation of bilateral agreements and related reforms. (Country Reports of Egypt,

Tunisia, Israel, Jordan and Morocco can be downloaded at http://ec.europa.eu/world/enp/documents_en.htm.)

The Mediterranean Action Plan's *Blue Plan* initiative is developing environmental performance indicators at national and project level.

### Global Water Partnership – Mediterranean

The Global Water Partnership – Mediterranean (GWP-Med) is a Regional Water Partnership of the Global Water Partnership (GWP). GWP-Med and is a platform bringing together competent organizations working regularly on water issues in the Mediterranean region. GWP-Med's goal is to promote and exchange knowledge on Integrated Water Resource Management (IWRM) for the sustainable use of the region's water resources. (More information on http://www.gwpmed.org.)

### Bilateral Co-operation: Programa Azahar

The Azahar Programme is an initiative of the Spanish Agency for International Cooperation aimed at improving human development in the Mediterranean Basin countries, while preserving their natural resources and ensuring proper environmental protection.

The Azahar Programme involves actions concerning land preservation, sustainable water management, renewable energies and the efficient use of energy, sustainable development, sustainable production, and environmental planning and management. The programme relies on the extensive experience and knowledge that Spain can offer in those areas.

# Part I
# Key Notes Presentations

# Grounding Security, Securing the Ground

**Grégoire de Kalbermatten**

## Introduction

I would like to open these lines by paying tribute to the Government of Spain which brought the bottom line challenge of land and water scarcity on the agenda of the international security debate. The adoption of the Madrid Declaration on Environment and Security by the 56 ministers of the OSCE membership is an expression of this achievement. Spain has provided true guidance as a thought leader in it dual capacity as OSCE and UNCCD Chair. The responsiveness of the OSCE and NATO is an encouragement for those of us who have been dealing with these issues for some time now.

In presenting the Fourth Global Environmental Outlook last October, the UNEP Executive Director sums up with a warning call: "*the human population is now so large that the amount of resources needed to sustain it exceeds what is available at current consumption patterns*".

It is fair enough to conclude that the planet is stressed. Here in Valencia we are looking at these stress factors at the scale of a particularly fascinating region, the Mediterranean. We trust this review can inspire similar analysis to foster cooperation in other regions.

## About Methodology

When we are considering the continuum between economics, society, environment and security we need first to clarify the methodological challenge at hands. It relates to our tendency to favour or strengthen analysis over synthesis. The old model of Terence who projected European humanism on the basis that "nothing which

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relates to man is foreign to me" (*rien de ce qui est humain ne m' est étranger*) was echoed by the French philosopher Michel de Montaigne ("*chaque home porte en lui l'entiereté de la condition humaine*). The classical model of the *honnête homme* was to be polyvalent, culturally connected and switched on. Such pretences have been left well behind. Today, we go about knowing in a different manner.

I trust that, like me, you had the opportunity to visit a doctor. As we can see in allopathic medicine, man has become the composite aggregate of diverse parts, each investigated by its respective set of eager hyper specialists. However man as a whole gets lost in the picture. This is the way modernity claims to corner the field of knowledge.

It seems we handle the health of our societies in the same way. Our universities, as well as the structures of our administrations have followed a corresponding pattern where they promote sectoral expertise, thinking in separate silos and specialization. We tend to grasp an issue in seizing its constitutive parts, investigate them thoroughly, no doubts, but only too often we fail to identify the constitutive linkages or relationship between them that explain the evolution of the complex system.

Hence let me start by a first conclusion. Comprehending in a mutually reinforcing manner development and environmental security requires expanding our grasp through trans-disciplinary research, cross-sectoral analysis and a broad systemic approach.

Notwithstanding the complexities of post modern societies, interdependencies and globalization, we need an enhanced capacity for synthetic thinking, for simplifying and reducing the perceived trade-offs and equations to identify the strategic entry points for feasible and solution oriented policies. A given region is probably a correct scale for comprehending such synergies.

## A Changing GEO Strategic Context

It is interesting to note how the term "security" can translate in its contrary. For instance, in some countries, a visit from security forces, possibly in the middle of the night, does not really boost the personal sense of security of those who receive the visit.

The point being that security is best ensured when armed forces and their like do not need to intervene.

The North Atlantic Treaty Organization indeed has been perceived as a very successful military alliance chiefly because it did not come to fight its opponent, the troops of the Warsaw Pact. This follows the paradigm *si vis pacem para bellum* (if you want peace prepare for war) that illustrates the deterrent role of a military alliance.

Hence the concept of public security has evolved from a more *stricto sensu* notion of resisting aggression or maintaining public order to a more holistic notion of removing the conditions that can lead to a security threat. In that context many countries are redefining national security.

Beyond the expansion of the concept to include economics, it becomes clear that the security establishment now include in its analysis natural resource, environmental and demographic issues. Declarations made in 2007 by the US Chief of Staff or investments by the Pentagon and the US Security Agencies in research linked to climate change related issues soberly confirm the trend.

There is a growing convergence of minds that, from a geo-strategic point of view, we need to focus on the sustainable management of natural resources and maintain the delivery of eco system services.

## The Partnering Role of NATO and OSCE

The North Atlantic Treaty Organisation was molded by the political environment of the cold war, its attention focuses on the armies of Eastern Europe, the threat of an onslaught of mechanised armor divisions through the Fulda pass or the launching of ballistic missiles. Since the fall of the Berlin wall, NATO has identified other threats and a consequently evolving mission, focuses more, in a preventive sense, on the context of the civil society in regions outside the territory of the alliance.

I remember a vice admiral on NATO's planning command explaining the meaning of having troops in Afghanistan. NATO recognises that the ongoing military operation corresponds to a short window of opportunities and that real stabilisation of the Afghan society depends on socio-economic development. In other words the ultimate success of the objective of the mission does not depend on the military capability of NATO. Yet the paradox is that the amounts invested in military and security operations are vaster then those invested in development.

This cannot be the long-term solution and this is why institutional coalition building is important. NATO adjusted to do just this and expanded its scope as an instrument for multilateral security co-operation. It facilitates political dialogue, capacity for networking, and applying technical expertise to problem solving. So perhaps we see here the emergence of a shift of paradigm for a preventive role of a military alliance: *si vis pacem, para pacem* (if you want peace, prepare peace).

In the same vein, we found first hand that OSCE can operationalise its capability to enhance peace and security through well targeted initiatives in the economic, environmental and social fields. In this respect the launching of a drought management center in Central Asia by the countries of the region, OSCE and UNCCD supported by WMO is an illustration of a concrete initiative facilitated by multilateral cooperation. We trust that the forthcoming OSCE presidencies will encourage the organization's staying power on desertification issues. We must see these initiatives maturing to bring the expected accomplishments.

Both organizations continue to plan for the threats of tomorrow. But, under scenarios of climate change, the day after tomorrow is irrupting in our present and an increasingly restless public opinion is not sure the international community is prepared for it. Interventions in neighboring or more remote countries, as we just saw, inform NATO that its future focus, beyond the challenge that terrorism poses

to the alliance's military capabilities, will include the implications of the scarcity of natural resources.

And, after all, this is only natural. History tells us that conflicts triggered, prolonged or expanded because of competition for access to natural resources have been the rule rather than the exception. This is true up to WW II: Stalingrad was meant to secure the road to Baku and its oil fields and the Japanese fleet was scrambling to secure the flow of necessary commodities to the mainland. Again, the term security is volatile.

In the postwar prosperity period, one may argue that, since the creation of the United Nations, the international community has increased its capacity to solve its dilemmas and challenges through peaceful means. However NATO and OSCE would probably plead for wise vigilance. Issues must be tackled before the man with the gun grabs them.

How do we bring land and soil in this equation? To be graphic, should we refer to the condition of the range when a certain Mongol nomad later known as Genghis Khan was pushed out of the ancestral grazing pastures? I am fond of referring to a study of the Federal Institute of Technology and of the Peace Institute in Zurich, which has tried to make the case.

As the UN Security Council has now deliberated on issues of climate change and security, let us not forget that, for billions of lower income people in the drylands, climate change – an abstract concept – translates in concrete and daily challenges: income, survival, combating desertification and drought, accessing water and food.

Water and food in the drylands is getting scarce. Allow me not to elaborate here on the relationship between desertification and forced migrations and desertification and conflicts that we have already presented in the precedent meetings in Almeria and Valencia or at the recent OSCE Forum in Prague. You know it is claimed that 50 million people are at risk of migrating because of severe desertification over the next 10 years.

Who is ready for this?

## Land, Soil and Desertification

Land degradation and the widespread loss of fertile topsoil in terms of quality and quantity is not a sudden event, but a gradual process, a creeping as well as a silent disaster. The effect of soil degradation is often not conspicuous, but nevertheless potentially very damaging, considering on one hand the soil's slow formation rate of 100–400 years/cm of topsoil and on the other side the irreplaceable value of soil in respect of maintaining ecosystem services and securing sustainable livelihood.

As I recalled at the opening of our COP 8 in Madrid last September, Desertification and drought are slow – but effective – killers that do not grab headlines like tsunamis or earthquakes. Perhaps because long terms measures and issues fail to catch the shorter-term attention of politicians and investors, decision makers have been unhurried to identify this pressing global threat.

When we are bringing in the equation climatic trends with its impact on increased aridity, water erosion, forest fires and drought, we are talking here about a major emerging factor of environmental scarcity with wide socio-economic implications in all regions of the world. The challenge is not limited to the drylands: salinisation in the large irrigation systems of Asia, deforestation and land slides in Latin or Central America, loss of organic nutrients and pollution in the soils of developed countries, compaction of soil due to infrastructures everywhere are some aspects of an ongoing aggression on soil health.

The "land" challenge is intimately linked to water management issues. It lies in balancing the maintenance of the soil's biological, chemical, physical and productive properties, with recognition of the land's role in sustaining human well-being, and acknowledgment of the broader development links with political and economic processes. The scientific community has widely and long recognised that soil and, more broadly, "land" is a valuable, finite resource, and that its sustainable future needs to be assured. Soil is at the heart of the process of land degradation. A good soil health is a prerequisite for the provision of most of the ecosystem services in drylands.

The fertility of soil may face renewed challenges now if the waste of the biomass is removed and diverted towards the production of energy. We are told the World Bank estimates that filling a gas tank of 100 L oil is the equivalent of over 200 kg of wheat. What shall be the choice of our supposedly humanistic society: filling gas tanks or filling empty bellies? There must be a way to face this dilemma in a different manner.

In December 2006 the United Nations University released a study entitled. "Overcoming one of the greatest environmental challenges of our times: re-thinking policies to cope with desertification" In the introductory words of its Rector:

> Desertification is one of the most pressing global environment challenges of our time, threatening to reverse the gains of sustainable development that we have seen emerge in many parts of the world. It is a process that can inherently destabilise societies by deepening poverty and creating environmental refugees who can often add stress to areas that may not yet be degraded.

I have already referred in other forums to statistics touted by the Internal Union of Soil Scientists suggesting that, over the last 300 years the average soil loss was 200 million tons per year; and in the past 50 years this average has reached 760 million tons. Six million hectares in annual loss to soil degradation is irreversible and an estimated 1860 M ha, or little more than half of the desertified area worldwide, requires rehabilitation. The cost of rehabilitation over a 20-year period has been calculated to be about US $213 billions. If not rehabilitated, the income foregone (over a 20-year period) could equal staggering US $564 billions.

Behind numbers we are concerned with people. Commenting on ecosystems and human well-being, the Desertification Synthesis of the Millennium Ecosystem

Assessment, a major study in the field, encourages more integrated, forwards looking policies. It confirms that:

> Desertification is potentially the most threatening ecosystem change impacting livelihoods of the poor. Persistent reduction of ecosystem services as a result of desertification links land degradation to loss of human well-being.

It an era of prosperity it was easy to take for granted the ground on which we stand and the land that feeds us but we may continue to do so at our own peril:

- We are aware of the current scenarios of climate change/climate variability and their impact on worsening extreme weather events.
- We are aware that correlations between demographic growth, poverty and decreased availability of arable land threatens food security.
- We are aware that drought and desertification worsens water supply and sanitation conditions for over one billion people.
- We are aware that the consequent scenarios of mining non-renewable or slowly renewable natural resources create a generational equity gap of fateful consequences.
- And finally we are aware that consumption patterns and growth trends in large emerging economies put considerable further pressures on these final resources.

Being aware of these factors, the corollary should be recognition that a major environmental threat such as desertification brings considerable disruptive factors for the socio-economic security of nations and interstate relations. Being aware of these factors can we do something about it and use the instruments that were created to this effect?

The magnitude of these disruptions can reach a political breaking point and exposes the slow response of the international community in establishing a policy paradigm for environmental security.

Mismanagement of the environment contributes to reduced security in a direct and an indirect manner. From the feedback of UNCCD Parties, we quote, in the first instance, a local resurgence of the conflicts between pastoralists and sedentary communities for the access to water.

My colleague Boubacar Cissé will remind us that conflicts for water and arable land often appear to be ethnic – and indeed may have evolved into such – but they risk misinterpretation if we ignore their origins in resource disputes and poverty. Although these conflicts may be described at local level, notably in an African context, they also exist on other scales. In a more indirect manner there is a growing competition for water between various sectors of the economy, between the city and the countryside, between the few rich and the many poor.

Clearly, valuing to its correct price the natural capital shall contribute to keep poverty in check, provide support to economic growth and confirm the role of global public goods in the sustenance of our societies. We need a Stern report on land and soil that will expose the cost of inaction and show the economic rational for investments in these fields.

## The Present UNCCD Context and Security Issues

You are of course well aware that, with its 192 Parties, the UNCCD is the only universal normative instrument dealing with land, soil and related issues. In the aftermath of COP 8 in Madrid last September and of its adoption of a forward looking 10 years UNCCD Strategy, the UNCCD visibly benefits from a more favorable environment.

The "10-year Strategic Plan and Framework to Enhance the Implementation of the Convention, also called 'The Strategy', puts a renewed emphasis on the problems related to land degradation and effectively portrays 'land' as the principal subject of sustainable development, as it links the halting of land degradation and sustainable land management to the amelioration of living conditions of populations and ecosystems and the provision of global benefits. The new strategy addresses the points above, by enlarging the scope of CCD action and promoting a proactive approach to awareness raising and advocacy, and the strengthening of the scientific capacity on land issues.

- This 10-year strategic plan and framework contains four strategic objectives that address the livelihood of people, the ecosystems, the overall global added value generated by the UNCCD, and the tools, namely the resource base, for the implementation of the Convention. These strategic objectives would guide the actions of all UNCCD stakeholders and partners during the period of 2008–2018.
- The strategy also contains five operational objectives that would guide the actions of all UNCCD stakeholders and partners in the short and medium term (3–5 years) with a view to supporting the attainment of the strategic objectives. These objectives focus on

  1. Advocacy, awareness raising and education
  2. Policy framework
  3. Science, technology and knowledge
  4. Capacity building
  5. Financing and technology transfer

The strategy identifies a number of objectives and expected impacts which are of interest to many processes as it brings down to earth the impact of global challenges on the everyday life on the billion of poor that still depend on natural resources for their survival.

- Improving and diversifying the livelihood base and benefits from income generated from sustainable land management
- Reducing populations' socio-economic and environmental vulnerability to climate change, climate variability and drought
- Enhancing land productivity and other ecosystem goods and services in affected areas in a sustainable manner
- Reducing the vulnerability of affected ecosystems to climate change, climate variability and drought

- Contributing to the conservation and sustainable use of biodiversity and the mitigation of climate change through sustainable land management and combating desertification

As stated in its mission, the strategy provides a *global framework* to "support the development and implementation of national and regional policies, programmes and measures to prevent, control and reverse desertification/land degradation and mitigate the effects of drought through scientific and technological excellence, raising public awareness, standard setting, advocacy and resource mobilization, thereby contributing to poverty reduction".

In other words, the UNCCD Strategy, puts a renewed emphasis on the problems related to land degradation, desertification and drought in a global context of climate change. As a matter of fact, it proposes a logical framework to better link sustainable development to the maintenance of eco system services and the reduction of poverty so as to provide benefits at all levels, from the global to the local. In short, the strategy focuses on the potential for sustainable land management to build up synergies that improve environmental governance.

The strategy has been well received by all constituencies and the exemplary leadership of Minister Narbona, the President of the COP, in achieving the positive outcome of the Conference must be saluted. You will note the strategy calls the secretariat to develop a comprehensive communication strategy.

As we move on to discharge our responsibilities in awareness raising, we remember that the next review cycle of the 16th and 17th sessions of the United Nations Commission on Sustainable Development (CSD) will focus on the issues of Africa, Agriculture, Rural Development, Land Degradation, Desertification and Drought.

Indeed, the environmental dimension of conflicts and migration points at the comparative advantage of the United Nations Convention to Combat Desertification, as a process and unique conceptual intervention platform to address the challenges of environmental stress, conflict prevention and the security–environment interlinkages.

We also make the point that UNCCD as an existing multilateral normative framework can establish in a credible manner the connectivity of issues and call for more integrated cooperation (international/multilateral; national/stakeholders involvement). This implies both top-down and bottom-up efforts.

Thus we remain interested in developing more preventive and comprehensive security approaches that include prevention of socio-economic and environmental conditions likely to threaten security and increase the danger of strife and conflicts.

Acting in the name of international law – the might of the law – is always preferable to acting in the name of more limited national interests – might is right. Everyone has a stake in the former, and so couching action in terms of a consensus normative framework universalizes a country's interests, comforts potential allies and provides the legitimacy for strategic alliances.

We trust that you share our understanding: the UNCCD as an "underutilised" SLM (sustainable land management) instrument of international cooperation and solidarity does, in the light of its new strategy, carry a great potential to become

one significant element in the response of the international community to emerging challenges exacerbated by climate change.

This could give us the opportunity to present a study as a contribution of the UNCCD and interested sponsors to better mastering the basis for sustainable development and security in the affected areas.

## Focus on Connections

1. The planned study should offer a state of the art synthesis with a convincing and credible level of conceptual innovation on "*Grounding security" or "securing of the ground*" by:
   - Securitising both natural and socio-political problems related to desertification (land and water scarcity) in the global drylands while reflecting the ongoing global policy and academic discussion on a widened and deepened security concept
   - Securitising the impacts of desertification and land degradation on natural hazards (drought, dust storms, forest fires, downstream flooding, watershed mudslides)
   - Securitising the societal outcomes (internal displacement, distress and forced migration, famine, manifold crises and violent internal and international conflicts) reinforcing each other as complex emergencies

We believe that combating desertification is a strategic entry point to address vulnerability issues, secure conditions for ecosystem maintenance, achieve the Millennium Development Goals, reduce the impairment of global carbon sequestration capacity and reduce also risk factors that could lead to forced migrations and social instability.

2. The expected focus on connections to establish would include:
   - Causes: desertification in combination with water scarcity, degradation and stress, population growth, food and health security
   - Spatial application: global, with a specific focus on Africa, Latin America, the Middle East and North Africa (MENA), Europe, Central Asia and China
   - Impacts of climate change and desertification: natural hazards and disasters (catastrophes)
   - Relationship between desertification/drought and the loss of a sustainable livelihood due to hunger, forced and distress migrations, crises and conflicts
   - Risks and costs of non action: impacts of business as usual climate change scenarios
   - Long-term trends or implications related to natural resource scarcity in rural areas in the drylands under scenarios of climate change with perspectives up to 2020, 2050 and 2100

– Outlining global, regional and national policy strategies and responses would cover bringing sustainable income to rural areas/drylands by enhancing sustainable pastoralism and agriculture (soil and water management, ecotourism) and e.g. by environmental services and renewable energy. This would include an overview survey of:

  - Developing a path for sustainable solutions, including in the UNCCD context.
  - Combining traditional indigenous and modern scientific and technological knowledge in:

    i. Water harvesting and management
    ii. Sewage, recycling and reuse of treated water
    iii. Composting, terracing, association and rotation of crops, sustainable management of fallows
    iv. Grassland and reforestation with Nitrogen fixation from the air to the soil
    v. Combating forest fires
    vi. Exploiting the unused economic potential of renewable energy (wind, solar thermal and photovoltaic, biomass and waste, geothermal energy) improving energy efficiency

  - Technology sharing, joint development (adapted applications of low-cost and locally produced tools combined with affordable advanced technology)
  - Crises and conflict settlement and resolution mechanisms

## The Mediterranean Region

At once diverse and one, the Mediterranean is no longer the *Mare Nostrum* of one of its neighbouring tribes. The region has a rich experience of conflicts and convergences, of cohabitation between pastoralist societies and sedentary structures, Islam and Christianity, diverging views or accommodating differences. In half a century its population will almost double from 285 million inhabitants in 1970 to 544 million around 2020. But if population stabilizes on the Northern shores, it explodes on the Southern one with a population of 116 million in 1970 jumping to 331 million in 2020.

At the same time water scarcity and drought in the region is on the rise as documented by the EC communication on the subject of the Council and European Parliament.

Some patterns may look similar in the 21 countries on all its shores, such as the littoralisation of the economy and tourism and the resulting demands for water, which compete with agriculture. Water stress issues are widespread. But differences are also apparent.

The Northern shore is well developed, the Eastern Northern shore, more mountainous is still developing. The Western and Southern shores are on the margins of the immense drylands areas that run from the Atlantic shores to border of China. There is no doubt that aridity is one of the faces of the Mediterranean region. Henceforth, focusing on the governance of natural resources is well tailored to address strategically the challenge of environmental scarcity in this region.

Research has pointed to the sensitivity of the region's ecosystems to the overuse of drylands resources in the western and southern regions of the Mediterranean contrasted with the very high population growth rate. Population do not exist or grow in a cultural vacuum and this is a reality that we tend to ignore although it is a factor that exerts an overwhelming influence on the way people respond to constraints and stress.

## A Reference to Cultural Perceptions in the Mediterranean Context

There are great merits of course in convening a meeting where ecologists and military strategists identify common concerns. May we stretch their thinking just a bit further and touch also upon cultural factors? They are all pervading and sometimes frame the hidden assumptions and possible webs of misunderstandings that affect a necessary dialogue.

Behaviour is strongly influenced by cultural conditionings. Cultural factors must be seen in a broad sense and include also the religious dimension even if we might all agree that faith is considered by many as an intensely private matter that ought not be discussed.

However history has shown countless time that religion mixes with politics. More recently, the occurrence of terrorism inspired by religious radicalization is a phenomenon that has been now investigated from various fronts. While religion does not appear on the radar of security planners, terrorism does.

Again, terrorism as such is not a new phenomenon. The 19th century knew its lot of anarchists and one could argue that the shooting at the Austrian Archduke in Sarajevo that triggered World War I had all the markings of a terrorist assault. It also points out to the fact that those seen by some as terrorists are seen by others as freedom fighters. We shall not touch this debate here. The aggression on the heir of the Austrian empire also tells that the security implications of a terrorist attack can get out of hands.

Researchers look at the resurgence of violent behaviour to express religious convictions or political aims in the context of socio economic terms. In this vein the export of poverty from the countryside to the cities, with desertification acting as a push factor, is seen sometimes as creating a "*lumpen Proletariat*" of environmental migrants that are losing their communal surroundings and role in society.

The loss of psychosocial identity can contribute to the need for reconstructing an identity around values perceived as stronger. Merchants of simplified dogmas and fake prophets of radicalised religions can capitalise on this need.

Indeed these processes have appeared at diverse period of history and in all religions. But greater understanding between diverse cultural groups denies them a fertile ground.

While such considerations may have an indirect but real bearing on changing security trends, they are mentioned here just to sketch a simplified description of the cultural landscape in which we operate. In the context of the Mediterranean it may be generally helpful to improve cross-cultural dialogue while clearing two levels of misunderstandings; one at the religious level, one at the moral level.

The first clarification thus deals with the religious dimension and the so quote clash of civilization or concept of "the fault lines of history", an assumption that old conflicts across the Mediterranean, between Christianity and Islam, will reappear. However, recognising that life in Europe today is more influenced by secularism than traditional beliefs, should we not assume that the driving cultural relationships today are not between the faiths of the Mediterranean shores but between these respective faiths and the impact of secularism? The projection of a revival of ancient armed conflicts is not well founded.

The second clarification deals with morality. The hypothesis submitted here is that no shores have the monopoly of morality. It is not infrequent that cultural community tends to think they have some sort of moral hedge over the others, focussing on their neighbours alleged troubles. For instance, Northern countries may focus on governance or corruption issues of Southern countries while these tend to see the moral hedge of their societies on another front. At times, they look at social statistics in advanced developed societies on the Northern shores as an expression of moral flaws in terms of lifestyle or erosion of family values. All Mediterranean societies, in fact, are in a process of coming to terms with some or other implications of secularism in a post modern and global context.

Reciprocal misperceptions will probably stay with us for some time. To overcome them in the region, it is advisable to seize issues that bring shared ethical values and common interest.

In the Mediterranean region for instance, participatory cooperation between the EU political space and its neighbours could be articulated around the maintenance of ecosystem services, agriculture and rural development and would propose a test case for generating mutual respect and balancing complementary economic interests in the context of globalisation.

Promoting a territorial approach for local development, also under the new UNCCD Strategy, shall give a renewed impulse to rural development and reaffirm the identity of a community in relationship to its territory and the defence of its ethnic and cultural heritage.

## About Possible Responses and the UNCCD

What can be done in the context of the Convention?

1. UNCCD welcomes collaboration on request between UNCCD focal points in affected countries, UNEP Plan Bleu, OSCE and NATO to identify hot spots in the nexus environment/security and security/environment.
2. The comprehensive information strategy to be prepared by the secretariat can include initiatives contributing to identify solution-oriented responses to the dilemmas of environmental security.
3. Amongst tested approaches, the decentralised governance of natural resources will encourage the wise blend of new and traditional technologies and best land use practices.
4. Thus lessons learnt can be advocated and participatory eco-development promoted though an agro-environmental focus to diversify economic activities, reduce poverty, and manages water and biomass resources in a sustainable manner.
5. Cooperation between the UNCCD Regional Implementation Annexes can offer a platform to further exchange information, probe desertification and security issues and advocate policies to support territorial collectivities.
6. Reducing uncertainties and reducing knowledge gaps on desertification through information gathering, long term remote sensing and sub-national biophysical and socio-economic data may clarify the relationships among land, climate change, biodiversity ecosystem services and human well being and public security. Enhanced involvement of the scientific community in the context of the Committee on Science and Technology of the UNCCD (CST) should help.
7. Therefore, better monitoring and regular reporting on the state of land as is done for climate by the IPCC is desirable. A call for an Intergovernmental Panel on Land and Soil has been made in the international scientific community and should be encouraged in the context of the CST.
8. Finally, some of our parties advocate as a pertinent measure the training of the armed forces. Indeed the army has a huge comparative advantage in terms of logistical capability and could be usefully engaged for disaster relief, which is already often the case, or less frequently, for targeted support to critical environmental action such as a tree planting campaign or the rehabilitation of waster harvesting infrastructures.

## Conclusion

The efforts of the international community to identify a practical public defence concept may end in entropy rather than synergy if we fail to establish driving connections in the area of environmental governance and security.

The UNCCD process under its new 10 years strategy can exploit its normative comparative advantage and, while joining hands with partner institutions and

programmes, bring forward a better integrated response from the international community to the oncoming identified challenges for sustainable land management.

NATO and OSCE members can apply the analytical power of these organizations to decipher the oncoming geo-strategic risks the membership is facing. This shall raise the policy visibility of critical issues handled by the UNCCD.

The Convention process can definitely help in promoting best practices for SLM including participatory eco development at a territorial or sub regional scale in the context of the National Action Programmes.

When eco development and security issues shall be perceived and addressed in their interdependency, involving the local population that are affected, the term security is more likely to have the same reassuring meaning for everybody on all shores of the Mediterranean.

# Status of Desertification in the Mediterranean Region

**Uriel N. Safriel**

**Abstract** Assessment of the status of Mediterranean desertification requires a robust and agreed upon definition of desertification, which is still lacking, partly due to the widespread use of "desertification" either interchangeably or in conjunction with "land degradation". By definition desertification is a subset of land degradation confined to drylands, thus adding "land degradation" to "desertification" implies relevance of the UNCCD to land degradation in both drylands and non-drylands, globally and in the Mediterranean. Another interpretation for pairing "desertification" and "land degradation" is that desertification is not a globally spatial but a dryland temporal subset of land degradation; namely "desertification" represents culmination of the process of land degradation in the drylands. The UNCCD usage of "desertification" (to be combated) in conjunction with drought (to be mitigated) and climatic variations (a desertification driver) also confounds understanding and assessment of desertification and its status. Qualifying desertification as a *persistent* reduction of biological productivity in the drylands may resolve difficulties in addressing desertification, though no agreement exists as to what degree of degradation and its reversibility properties would qualify as desertification.
Desertification is habitually believed to be driven by human impact proportional to population size and growth rate, which are higher than the global average and relative to all other ecosystems, respectively. Global scale data demonstrating that desertification is highest at the intermediate section of the aridity gradient suggest that desertification is driven by an interaction of ecosystem sensitivity (expressed by natural biological productivity) and the pressure exerted on land resources (expressed by population density). Yet, though GDP and infant mortality rates are lower and higher in drylands, relatively to other ecosystems and to global averages, respectively, it is not known if the drylands' low human well-being is driven by desertification, or by the inherently low productivity of drylands impacted by growing populations, or both. Thus desertification constitutes a paradigm, one of a

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downward spiral of degradation leading to human misery, through self-reinforcing positive feedback loops. This paradigm is reinforced by an environmental security narrative, in which migrations and conflicts driven by the desertification-associated demand and supply-induced environmental scarcities, reduce overall environmental security in the drylands. A "counter paradigm" based on some evidence suggests that drylands' adversities trigger "induced innovations" in rural communities that lead to development tracks which circumvent desertification. Yet, if dryland population continues to increase the "induced ingenuity" will eventually be exhausted, unless dryland livelihoods independent of land productivity are gradually adopted.

Mediterranean climates, of wet winters but dry summers, prevail in five seaboard semiarid and dry-subhumid regions on the globe, one of which is the Mediterranean Basin, with a long history of intensive use by man resulting in biological adaptations providing high ecosystem resilience to human impact. The southern, African lands of the Mediterranean Basin are drier than the northern, European lands, the latter being mainly semiarid drylands, with high desertification extent, yet more people are affected by desertification in the southern than in the northern sections of the Basin. All over the Mediterranean Basin the most extensively used land is also the most intensively used and becoming most degraded, irrespective of type of use. Thus in the northern Mediterranean desertification is driven by irrigation developments, themselves driven by markets and regional agricultural policies, whereas in the southern Mediterranean desertification is driven by encroachment of cultivation on rangelands, which are driven by population growth and national policies. Yet, the Mediterranean ecosystems are fairly resilient to mounting external pressures, due to a balance in the interaction of soil state with soil vegetation cover, up to a point in which a threshold is crossed.

A way to avoid desertification in grazed Mediterranean shrublands is to encourage the historical prevalence of a spatio-temporal mosaic of distinct patches of annual and perennial vegetation through controlling grazing and fire at moderate levels, and moving these controls adaptively and dynamically between patches. Yet, when degradation did take over, rehabilitation through afforestation have taken place on a large scale in the Mediterranean Basin. This afforestation, mainly with Aleppo Pine, reduced soil erosion and flooding but compromised water resources and poorly performed in restoring the indigenous vegetation cover, but seemed to be more successful and water-efficient in drier areas, where the objective was soil conservation rather than the vegetation restoration.

Global climate change is projected to exert an additional pressure on the Mediterranean drylands, through an overall decrease in water resources, such that even a relatively small climatic change would suffice to initiate a spatio-temporal transformation of the Mediterranean semiarid to arid drylands, and also an overall transformation of non-drylands into drylands, in both their climate and their biological productivity. Given the projected combined impacts of global climate change, dryland population growth and the pressure on drylands brought about by global decline in good cultivable land, it may be effective to address Mediterranean desertification as an environmental security issue, which encompasses risking food security, health security, livelihood security, national and transboundary security. However,

the direct links between desertification and migration within the Mediterranean Basin have not yet been demonstrated.

Even though means to promote land productivity improve, an eventual widespread desertification leading to reduced human well-being, land desertion and migration can emerge in the Mediterranean Basin. A way out is to explore means of diversifying dryland livelihoods, such that the pressure on land resources is reduced yet dryland people opt to stay on their land. Paradoxically, with all its drawbacks, global climate change provides opportunities to people of the Mediterranean drylands, encouraging them to diversify their livelihoods, e.g. afforestation in the non-desert Mediterranean drylands for carbon trading, and solar energy development in the desert drylands for exporting electricity. These and other livelihoods of advantage in drylands yet not depending on dryland land resources can be mixed with improvements of traditional dryland livelihoods. Thus the flows between the southern and northern Mediterranean may dramatically transform – rather than development aid cash, payments for purchases of clean energy would flow from the North to the South, and the South–North flow of migrants would be replaced by North–South flow of tourists. These changes would promote the sustainability of dryland livelihoods especially in the South, and would bring abut environmental security and subsequent political stability throughout the Mediterranean Basin.

## Introduction

A pre-requisite for assessing the status of desertification at a regional scale, just as for assessing it either at the local or at the global scales, is a clear perception of what "desertification" is. However, it seems easier to agree on what it is not than to define what it is. Given the most recent definition of "desert" (a region of an arid or hyperarid climate inhabited by species adapted to aridity, and having large contiguous areas with bare soil and low vegetation cover, Ezcurra, 2006), then desertification is not "the advancement of the desert" or the process through which a desert takes over a formerly non-desert area. This is so for two reasons. First, the regions claimed to be currently desertified mostly have a semiarid climate (and not arid or hyperarid). Also, using the highest estimates, desertification is claimed to have already taken over some 30% of the global land (Safriel, 2007) and deserts comprise 33% of global land (Ezcurra, 2006). Given these two figures, then since desertification is the relatively recent transformation of non-deserts to deserts, nearly all current deserts would have been recently formed by human actions, what contradicts geological and historical evidence.

So, what is desertification? This has been debated ever since the term was coined in the early 1940s of the 20th century. Following the first four decades of use, the concept of "desertification" had to be reviewed twice ("Desertification – a review of the concept", by Glantz and Orlovsky, 1983, and "Defining desertification – a review", by Verstraete, 1986). Nevertheless, until this day most publications dedicated to desertification (e.g. Rubio et al., 2006) include a paragraph, if not a section,

in reviewing or redefining desertification. For example, the definition used recently by Reynolds et al. (2007) – "Desertification is the emergent outcome of a suite of social and biophysical causal factors, with pathways of change that are specific in time and place" can be compared with the one used more than a decade earlier by Lindqvist and Tengberg (1993) – "Desertification is land degradation … Degradation implies reduction of the resource potential by one process, or a combination of processes, acting on the land".

This chapter, inevitably, attends the definition of desertification and then addresses its global occurrence, drivers and impacts. The chapter then explores the status of desertification and its security linkages in the Mediterranean region. Finally, projections of global climate change and their implication for Mediterranean desertification are explored, and options for attaining environmental security in the Mediterranean Basin are proposed.

## Global Desertification

### *What Is Desertification?*

#### Desertification as a Geographical Subset of Land Degradation

A stumbling block in qualifying the term "desertification" is its widespread use either interchangeably or in conjunction with, the term "land degradation". Referring to the text of the United Nations Convention to Combat Desertification (UNCCD) adopted in 1994, desertification constitutes a subset of land degradation – it is land degradation, but confined to three climatic regions – the dry subhumid, the semiarid and the arid areas (UNCCD, 2007a), a definition burrowed from Agenda 21 adopted by the Rio de Janeiro Earth Summit in 1992 (UN, 2004). These three climatic regions, together with an additional driest one, the hyperarid, were aggregated in the World Atlas of Desertification (Middleton and Thomas, 1997) to comprise the global drylands. The Millennium Ecosystem Assessment (MA) qualified desertification as land degradation in all drylands, the hyperarid included (Safriel and Adeel, 2005). Thus, since desertification is land degradation in the drylands, then when "desertification" is used, land degradation is implicit. However, ever since the UNCCD entered into force in 1996, the term "desertification and land degradation" has been used in the UNCCD and the dryland contexts, by most stakeholders and in an ever increasing number of publications.

The tendency to use "desertification" in conjunction with "land degradation" although desertification is land degradation though in the drylands only, may be associated with the emerging trend to view the UNCCD as a convention relevant not just to drylands, but to all global lands at risk of degradation or already degraded. This trend may be linked to the increasing number of non-dryland developing countries that acceded and ratified the UNCCD since its entry into force in 1996 (the

ratio of non-dryland to dryland developing countries that ratified the Convention rose from 0.33 in 1996 to 0.74 in 2004, Safriel, 2007). The trend was accelerated when a fifth regional implementation annex, that for Central and Eastern Europe "region" was added to the Convention in 2001, on top of four regional implementation annexes included in the UNCCD when adopted in 1994. Whereas "land degradation" does not appear in the Latin–American and the Northern Mediterranean Annexes and "desertification and land degradation" is not used in any of the four original regional annexes, "land degradation" and "desertification" feature jointly in the Central and Eastern European Annex V. Yet, though Article 5 of this Annex calls the Annex's countries to "identify … national objectives relating to desertification" and to "review progress in combating desertification", Article 2b, for example notes that there is a "variety of forms of land degradation in … the region … including the risk of desertification…" (UNCCD, 2007b). Indeed, of the 17 developing countries of the 5th annex, 11 have no drylands within their territories hence by the UNCCD definition they cannot be affected by desertification (Safriel, 2007). However, it is conceivable that when joining the Convention, these countries might have been motivated by the 2002 decision of the Global Environment Facility (GEF) to expand its mandate by adding "land degradation, primarily desertification and deforestation" to its portfolio. This was followed by the designation of GEF in 2003 as the financial mechanism of the UNCCD (GEF, 2005), what made this convention even more attractive to developing countries.

## Desertification as Extreme Land Degradation

The discussion in the previous section may suggest that when the term "desertification and land degradation" is used, it implies "desertification in drylands and land degradation in non-drylands". Thus, for example, this might have been the perception of the Executive Secretary of the UNCCD in his 2008 press release (UNCCD, 2007c) when suggesting "that the current food security crisis needs to be examined in line with the environmental change such as desertification, land degradation and drought (DLDD)". Namely, the environmental change is of a global scale, occurring both in drylands (although the term "drylands", the UNCCD's formal target and focus, is not mentioned in this press release even once!) and in non-drylands alike.

However, the above statement can be also interpreted differently. Just as "drought" is a unique process, so "desertification" and "land degradation" are independent entities, irrespective of whether they occur within or outside the drylands. This interpretation is supported by an alternative way of pairing "desertification" and "land degradation": already in the early 1990s of the 20th century the "and" was replaced by a slash, to make "desertification/land degradation" (e.g. Kadomura, 1997) for describing these processes within the drylands. This usage gradually replaced "desertification and land degradation" such that towards the end of the first decade of the UNCCD, in the Ten-Year Strategic Plan of the UNCCD adopted by the 2007 Convention's Conference of Parties "desertification/land degradation" is the

only form by which the subject matter of the Convention to Combat Desertification is presented (UNCCD, 2007d).

The reason for replacing "desertification and land degradation" with "desertification/land degradation" is not provided in the UNCCD documentation, nor is this form of presentation explicitly defined. But since this is habitually used in the drylands context, it can be suggested that this usage serves to highlight that desertification is a subset of land degradation in the drylands, in the sense that desertification is a culmination of the process of land degradation. Namely, it is suggested that when the process of land degradation in the drylands reaches an extreme state, this state is labeled "desertification". Thus, "combating desertification/land degradation" means targeting all stages of the process of land degradation in the drylands, whether or not the state of desertification has already been reached. This approach is also rooted in all the assessments of global as well as regional land degradation and/or desertification (for review see Safriel, 2007), that distinguished between different degrees of "land degradation" in the drylands. Most of them labeled all the degrees as degrees of desertification, while others ignored altogether "light", "moderate" and even the "severe" degrees and attributed "desertification" only to the "very severe" degradation degree (e.g. Lepers, 2003).

## Desertification as an Associate of Drought and Climatic Variations

The opening of the previous section pointed at one stumbling block in qualifying the term "desertification" – the coupling of "desertification" and "land degradation" in the UNCCD definition, in line with previous usages of the term. There are, however, additional stumbling blocks and these are not related to the UNCCD definition of "desertification"; rather, they are embedded in the extended name of this convention – "UN Convention to Combat Desertification in those countries experiencing serious *Drought* and/or Desertification". "Drought" is defined in Article 1 ("Use of Terms") as "naturally occurring phenomenon" in which "precipitation has been significantly below normal recorded levels . . . ", and though it is not explicitly included in the definition of "desertification" in Article 1 it is implicitly there – "Desertification means land degradation . . . resulting from various factors, including *climatic variations* and human activities". However, it is "drought" rather than "climatic variations" that is often paired with "desertification". For example, in the Regional Implementation Annexes of Latin America and the Caribbean the term "desertification" is never used alone, but in different combinations with "drought" ("desertification and/or drought", "combat desertification and mitigate the effects of drought", "combat desertification and/or mitigate the effects of drought"). In the other annexes these usages also prevail, though stand alone "desertification" infrequently occurs too (the only exception is the Northern Mediterranean implementation annex in which "drought" is mentioned only once, but not paired with "desertification"). When it comes to the 2007 Ten-Year Strategic Plan documentation, the subject matter of the convention consistently becomes a tri-partite term – "desertification/land degradation and drought" (as well as "combating desertification/land degradation and mitigating the effects of drought"). The issue

at stake is why and how desertification is linked with drought, given that drought is a natural phenomenon, and that the UNCCD definition attributes desertification to another natural phenomenon – climatic variations, but in conjunction with human activities.

To resolve this issue, it should be noted that drylands, the only ecosystems that by definition are prone to desertification, are defined by a climatic attribute – their water input or gain is much lower than the potential output or loss (the ratio of precipitation to potential evapotranspiration, i.e. the "aridity index", is lower than 0.65, which means that the potential loss from the soil surface and through its vegetation cover is at least about one and a half time higher than the precipitation) (Middleton and Thomas, 1997). This definition of drylands solely by a climatic attribute was also adopted by the UNCCD. But another critical climatic attribute of drylands is only alluded to by the UNCCD in mentioning "climatic variations" as a driver of desertification, apparently as significant as "human activities". Indeed, the nominator of the aridity index is a long-term *average* of precipitation, a value that conceals the intense, low-predictability between-year variation in annual rainfall that is so characteristic of the dryland climate, and so decisive in controlling the structure and function of their ecosystems just as or even more than the low average rainfall (Safriel and Adeel, 2005). Droughts, typical but not exclusive to drylands, actually constitute an extreme expression of this strong spatio-temporal climatic variability of the drylands. Therefore, drought can be viewed as a subset of "climatic variability"; hence the UNCCD definition actually implies that it is more a driver of desertification than an independent phenomenon to be somehow associated with desertification. This also suggests that "combating desertification" means both changing human behavior but also struggling with Mother Nature and that "mitigating the effects of drought" becomes a subset of "combating desertification", rather than an added action.

## Dryland Climate and Biological Productivity

Climatic variations (including drought) are not the only drylands' natural attributes to be grappled with by dryland people. The low precipitation and the high evapotranspiration leave only a relatively small amount of water (or moisture) in the soil, amount which becomes the limiting factor for biological productivity. Namely, biological productivity in all terrestrial ecosystems requires light, water, and nutrient resources as well as an appropriate range of climatic and edaphic features. But whereas other ecosystems may be limited by light, nutrients or temperature, it is only the dryland ones that are water-limited. Furthermore, this limitation puts the drylands at a disadvantage, and excluding polar ecosystems, drylands have the naturally lowest primary productivity, compared with any other major terrestrial ecosystems. This is demonstrated by aggregating all the global terrestrial ecosystems into seven major ecosystem groups, one of which is the drylands. Comparing the average biological productivity of all the global drylands combined with those of the other six aggregated ecosystems (Fig. 1a) yields the value of

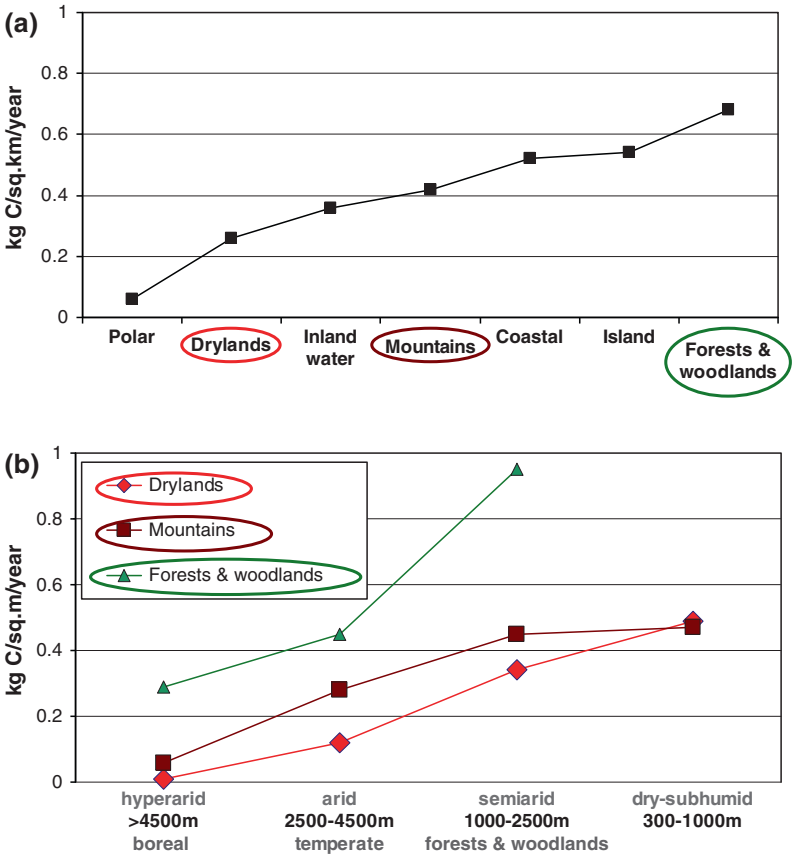


**Fig. 1** Natural Net Primary Productivity (NPP, expressed in kg carbon/m$^2$/year) of drylands compared to other aggregated natural ecosystems (data from MA, 2005). (**a**) Values are aggregated averages and (**b**) values are of distinct sections along the environmental gradient of drylands (aridity gradient), mountains (altitudinal gradient) and forests and woodlands (latitudinal gradient)

0.26 kg carbon/m$^2$/year for the drylands, a value lower than that of any other of the six ecosystems, and nearly a third of the value of the most productive one, that of the global forests and woodlands combined, which is 0.68 kg carbon/m$^2$/year, Another instructive comparison is between the response of productivity to aridity, of the different drylands positioned along the global aridity gradient, and the productivity of the other major ecosystems whose productivities are controlled by other environmental gradients (such as mountains and forests and woodlands that are controlled by altitudinal and latitudinal gradients, respectively). This comparison reveals that drylands are impacted by their limiting factor, water that change with aridity, more than the other ecosystems are impacted by their limiting factors, which change with altitude or latitude (Fig. 1b).

## Desertification as a Persistent State of Productivity Degradation

The relevance of biological productivity in the context of "climatic variations", "drought" and "desertification" is highlighted by the UNCCD text that depicts it as an indicator of desertification. Article 1 of the Convention not only define desertification as land degradation in the drylands, but it explains that this land degradation "means reduction or loss . . . of the biological . . . productivity . . . of rainfed cropland, irrigated cropland, or range, pasture, forest and woodlands . . .". Thus, desertification may be defined as "reduction or loss of biological productivity in the drylands", and given the above comparison of drylands' productivity to that of other ecosystems "desertification" implies a further reduction of the already inherently low natural productivity of the drylands. However, since productivity in the drylands is mainly a function of water availability, and since the drylands' climatic variability mainly involves rainfall fluctuations, biological productivity in the drylands is bound to fluctuate too (Safriel, 2007). This suggests that biological productivity in the drylands is frequently reduced, and especially so during drought years, but would rebound since rainfall lows are naturally followed by rainfall highs. Therefore, "reduction or loss of biological productivity" may be a temporary phenomenon, and would not necessarily count as "desertification".

There is no better example to the inadequacy of the UNCCD definition of desertification resulting in the misuse of the term, than the case of the Sahel droughts of 1968–1974 succeeded by the more severe one of 1983–1985. The human plight resulting from these droughts was attributed to land degradation brought about by the combination of the drought and the overexploitation of land resources by the burgeoning Sahel population. The first of these droughts prompted the revival of the term "desertification" and triggered the convening of the United Nations Conference on Desertification (UNCOD) in 1977, that adopted a Plan of Action to Combat Desertification (PACD). The second drought catalysed the United Nations Environment Program (UNEP) to conclude, in 1991 "that the problem of land degradation in the drylands had intensified" (UNCCD, 2007e), what lead to the adoption of Agenda 21 with its chapter "managing fragile ecosystems: combating desertification and drought" in 1992 and to the following intergovernmental negotiations on the UNCCD that initiated in 1994. However, satellite imagery of the period 1982–2000 demonstrated a clear trend of "greening of the Sahel" as of the termination of the drought and onwards (Safriel and Adeel, 2005). The question is therefore whether the observed reduced productivity during the drought years was "desertification" that had to be combated, or it was simply a demonstration of productivity tracking the natural climatic fluctuations, typical of the Sahel ecosystems.

This issue prompted the MA to refine the UNCCD definition of desertification by introducing the concept of persistence to the definition, by which desertification becomes a "*Persistent* reduction in biological productivity". This publication (Adeel et al., 2005) further explains that "Fluctuation in the supply of ecosystem services is normal, especially in drylands, but a persistent reduction in the levels of all services over an extended period constitutes desertification". Note that "ecosystem services" includes the service of "primary productivity", a "supporting service"

on which most other ecosystem services depend (MA, 2005). The operational power of this revised definition of desertification is best demonstrated by the difference in the course of productivity, along ca 15 years period, between two adjacent rangelands in a dry-subhumid area in NE South Africa, one managed by its owners and the other used as common grazing area (Fig. 2). The productivity of both rangelands tracked the rainfall fluctuations, but the productivity of the common grazing one, persistently lagged behind that of the privately owned, apparently well-managed range (Wessels et al., 2004). Given this example, and the MA refinement of the definition of desertification, one may question the appropriateness of implicating desertification as the cause of the Sahel famines in the late 20th century.

## Desertification as an Irreversible Land Degradation

The MA refinement of the definition of desertification enables controlling for climatic fluctuation for singling out reduced productivity that is desertification. The question remains though, whether the observed reduced productivity during the drought years was "desertification" caused by "human activities", or it was driven by the extreme cases (droughts) of the naturally occurring "climatic variations", which under the UNCCD definition can also constitute a driver of desertification. The issue of whether desertification is man-made or is driven by natural causes such as droughts has preceded the UNCCD and continues to add to controversies and lack of clarity about what is, where is and how much there is desertification on earth. This natural/man-made drivers' controversy is reminiscent of the old "nature or nurture" controversy, and may be resolved in a similar way. Namely, natural causes alone, including severe droughts, may not qualify as independent, direct drivers of desertification, whereas human activities associated with land uses that target biological productivity, may drive desertification independently of other, natural factors, and directly so. But severe drought may drive land users to increase their impact on the drylands, whose natural productivity is already inherently low. This increased impact then functions as a direct driver of desertification. Thus, in a way the UNCCD assertion that desertification is caused by both "climatic variations and human activities" is valid. But this is only when "climatic variations and human activity" interact, such that "climatic variation" is an indirect driver of desertification, through its effect on the direct driver, "human activity". The literature on the Sahel droughts and their aftermath suggests that indeed people responded to the droughts by increasing their impact on land resources, even though population size and stocking rates had been higher than usual prior to the onset of the droughts (e.g. Puigdefabregas, 1995).

Whether or not the Sahel events can be termed "desertification" depends on the issue of ecosystem resilience and reversibility (e.g. Mortimore and Adams, 2001). Undoubtedly biological productivity seems to have been restored in the Sahel following the droughts, resulting also in an apparent restoration of human well-being there. Thus, the reduction in biological productivity, maintained during the drought period had not been "persistent", since productivity was restored in response to the

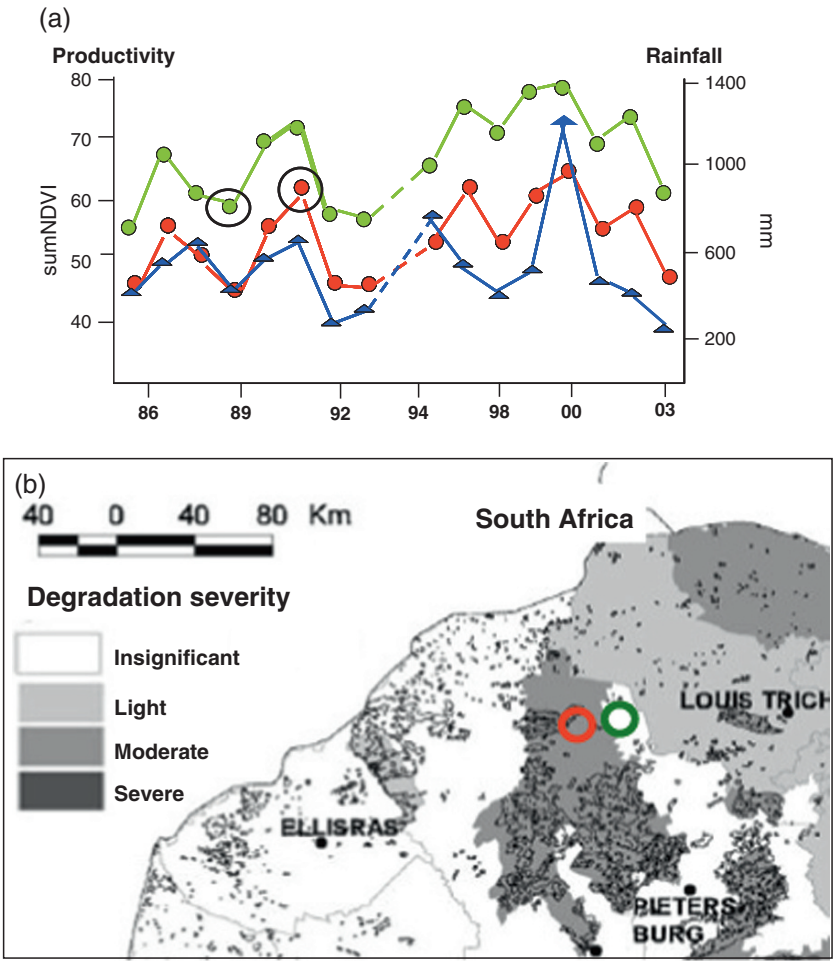


**Fig. 2** Climatic variations and land degradation in NE South African rangelands. (**a**) The effect of between-years (1986–2003) rainfall variations (*blue line*) on Net Primary Productivity (expressed by sumNDVI derived from satellite imagery). The green curve is for private farms and the red curve is for adjacent rangeland under common use [see map in (**b**)]. (**b**) Ground truthing of the satellite imagery. *Red circle* is the site of productivity depicted by the *red curve* – moderate and also severe land degradation. *Green circle* is the site of productivity depicted by the *green curve* – insignificant degradation. Note the two *black circles* at the curves in (**a**), demonstrating that productivity of the degraded site can be higher than that of the non-degraded site, but the productivity at the degraded site is lower than that of the non-degraded site at any given time, i.e. in-spite of the annual rainfall fluctuation productivity in the degraded site is persistently lower than that of the non-degraded site (curves and map are modified after Wessels et al., 2004)

resurgence of the non-drought rainfall pattern. And, it remains unknown what have been the relative contribution to the recovery of productivity – the amelioration of climate or human actions in "combating desertification", or their combination. One way or another, this much depends on whether desertification is defined as an

extreme state of land degradation, or degradation is defined as desertification only when it reaches a state of irreversibility, one in which for all practical purposes productivity cannot be restored, unless unreasonable resources are invested. To date there have been only a few attempts to explicitly define desertification as an irreversible state (Yassoglou, 1999, and see discussion in Glantz and Orlovsky, 1983). The process of bush encroachment driven by overgrazing may be the only case of a relatively common apparent irreversibility, even though even this has been challenged (Safriel and Adeel, 2008). Nevertheless, irreversibility is likely to be determined only through experimentation, in which the pressure believed to have caused desertification is removed, and rehabilitation efforts are applied. Currently the issue of desertification irreversibility remains unresolved.

To conclude, in the drylands context, desertification has been defined, described and addressed as (a) *any degree* of land degradation, expressed in reduced productivity, (b) an *extreme* reduction in productivity only, (c) a *persistent* reduction of productivity only, and (d) an *irreversible* reduction of productivity (Fig. 3). Given these diverse (if not somewhat contradicting) definitions or perceptions of desertification, it is no wonder that efforts to assess the spatial extent of desertification at the

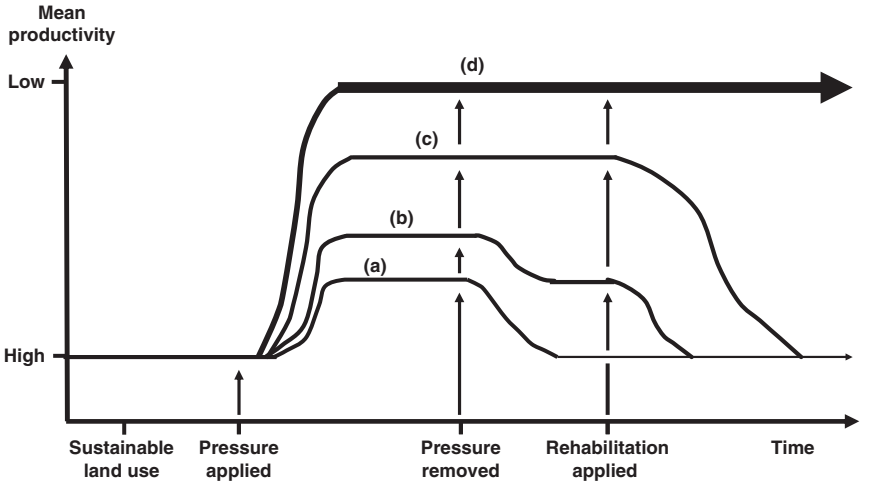


**Fig. 3** Land degradation in the drylands – when is it "desertification"? Curves represent the temporal trajectory of biological productivity (note that productivity declines from bottom to top of the ordinate). Thickness of curves stands for magnitude of the human pressure on land resources. (**a**) Lowest pressure results in a relatively small persistent reduction in productivity, and when this pressure is removed, productivity is fully restored, with no rehabilitation efforts required. (**b**) Medium pressure results in greater loss of productivity. When pressure is removed productivity is only partly restored, but rehabilitation efforts can fully restore it. (**c**) High pressure results in a substantial productivity loss, and productivity is restored only by rehabilitation, since just the removal of the pressure has no effect. (**d**) Extreme pressure drives the greatest productivity loss, which for all practical purposes is irreversible, neither through removal of the pressure nor through rehabilitation. All four types of land degradation in the drylands qualify as "desertification", depending on authors; whether case (d) (irreversibility) at all exists remains unknown

global scale yielded values ranging between 0.1% and 74% (!) of already desertified drylands (Safriel, 2007), which renders these efforts virtually useless. Nevertheless, it has been suggested that the range of 10–20% is relatively reliable as an estimate of the proportion of drylands (that comprise 41% of global land) currently desertified. In the following sections of this chapter the term "desertification" is used generically, with no qualification as to a specific definition.

## *Drivers and Impacts of Desertification*

### Human Demography, Biological Productivity and Human Well-Being

The UNCCD definition implicates "various factors" as the drivers of desertification, and among them, explicitly, "climatic variations and human activity" (Article 1a). As to the latter, there is a further elaboration in Article 1f, that implicates "land uses" and "habitation patterns". The literature is replete with suggestions and schemes of what these "human activities" may be (summarized and reviewed by Middleton and Thomas, 1997; Adeel et al., 2005; Safriel and Adeel, 2005; Safriel, 2006; Reynolds et al., 2007). Most of the sources do not elaborate on concrete data that support proposed mechanisms, but often conclude that generically, desertification is driven by "poor resource management" or "misuse", "inappropriate methods" and "overexploitation" of natural or land resources.

The MA made a clear distinction between direct and indirect drivers of desertification, in which the formers are social, economic and political ones, that drive the latter, which are the biophysical ones (Safriel and Adeel, 2005). Among the social drivers – the demographic ones may be decisive, but also the most controversial. Whereas many publications attribute desertification to "population pressure" (which implies "population size" or "population growth"), others highlight well-documented cases to support a contradicting view, e.g. "More people, less erosion" (title of the seminal book of Tiffen et al., 1994). It is likely, however, that though at the local scale it is not the high population size per se that drives desertification, at the regional and global scale, desertification, just as other environmental problems, is indirectly driven by the combination of population size and material aspirations, and their accelerating trends.

Indeed, at the global scale, population growth in drylands is highest, as compared to that of all other ecosystem types (Fig. 4a). This population growth rate of 18.5% during the last decade of the 20th century is 11% higher than the global population growth during that period. Furthermore, not only the rural population density of the drylands is 54% higher but also the drylands' urban population density is 19% higher than the global values for these variables (Fig. 5b). When these demographic statistics are combined with the already mentioned inherently low biological productivity of the drylands (Fig. 4a), these two drylands' attributes outweigh all other indirect social and direct biophysical drivers of desertification, respectively (Fig. 4a).

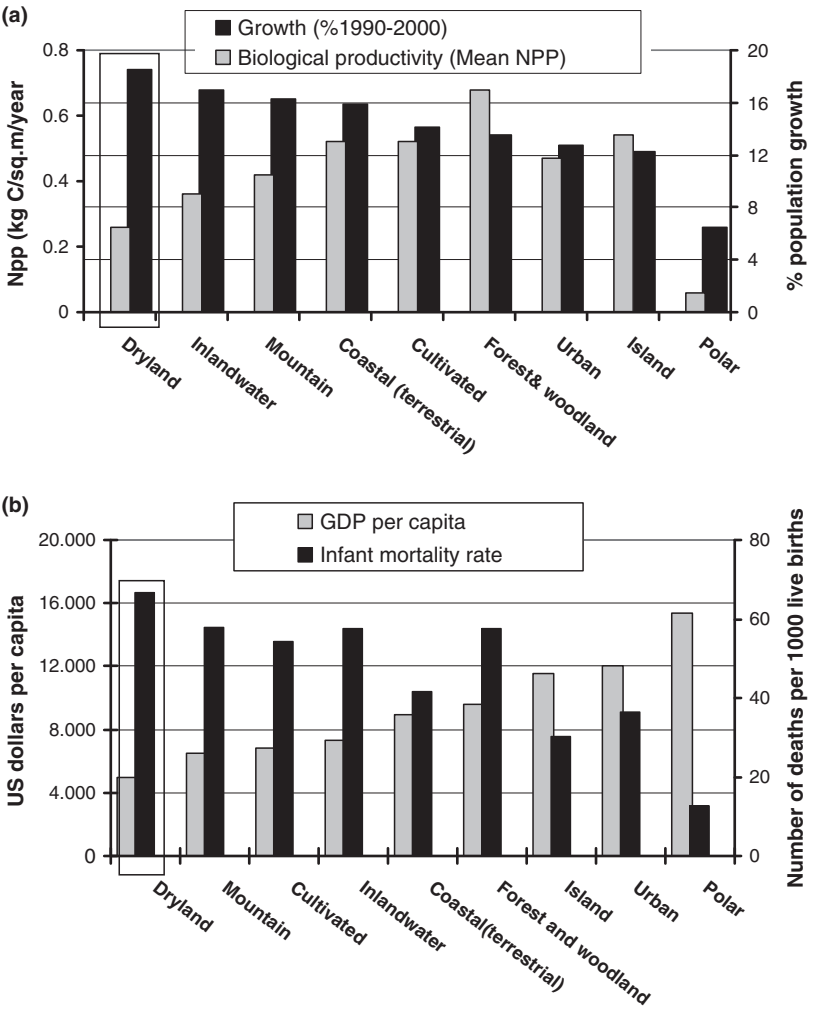


**Fig. 4** Comparing drylands to other MA ecosystems, with respect to attributes often regarded as drivers (**a**) and impacts (**b**) of desertification (data from MA, 2005). Note that drylands have the lowest natural productivity (the polar ecosystems excluded), the highest population growth rate, the lowest GDP per capita and the highest infant mortality rate. In (**a**) ecosystems are arranged in decreasing order of population growth and in (**b**) – in increasing order of GDP per capita

The prevailing narrative of desertification is its impact on dryland people, especially the rural populations, and this is through its expression of reduced biological productivity. This drylands response to this impact results in reduced human well-being, with poverty being its extreme state (Safriel and Adeel, 2008). Similarly to desertification itself, "poverty" is a contentious and controversial term, with a range of definitions and diverse estimates of its global extent. It is however evident that human well-being in the drylands is lower than that of people in other ecosystems, as

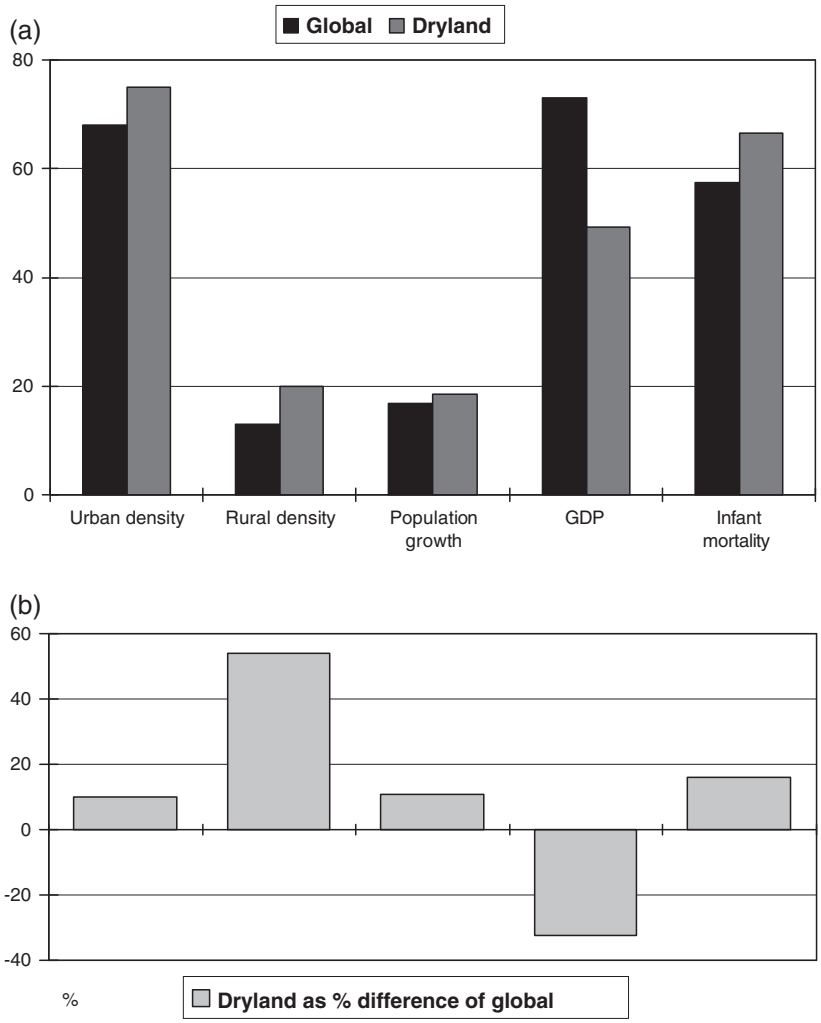


**Fig. 5** Dryland statistics vs. global statistics – urban and rural population densities and population growth rates (may be regarded as drivers of desertification), GDP per capita and infant mortality rates (may be regarded as indicators of desertification impact). (**a**) Dryland values compared to global values (data from MA, 2005) and (**b**) the deviation of drylands values from global values, expressed as percentages

expressed by such indicators as Gross Domestic Product (GDP) and infant mortality rates, which are lower and higher, respectively, than in all aggregated ecosystems (Fig. 4b). Furthermore, the dryland GDP and infant mortality rate are 32% and 16% lower and higher, respectively, than their global values (Fig. 5a, b).

The statistics of population growth and of the natural biological productivity displayed in Figs. 4 and 5 constitute hard data, yet they by themselves do not

necessarily qualify as drivers of desertification. Rather, it can be equally claimed that the unfortunate combination of high population size and growth and low natural productivity are sufficient to reduce human well-being in the rural drylands, before desertification (which is further lowering of the already low productivity) takes over, or even without desertification ever occurring. Nevertheless, there is at least one observation, at the global scale, that may support placing desertification as the intermediary between low productivity and high population growth to low GDP and high infant mortality rate.

This observation emerges when the global drylands are disaggregated to subtypes (segments along the aridity gradient, e.g. Fig. 1b), and values for the spatial extent of desertification generated by the most comprehensive assessment to date (that of GLASOD, see Rubio and Recatala, 2006; Safriel, 2007) are used, a non linear relations between desertification and aridity is evident – the spatial extent of desertification in the hyperarid dryland is the lowest, but the highest desertification extent is not at the least dry drylands (the dry-subhumid), but at the semiarid ones (Fig. 6). These functional relations between desertification and the degree of aridity can be understood if desertification is perceived as driven by an interaction between human pressure and ecosystem sensitivity to pressure. The observed hump-shaped curve of desertification across the drylands' aridity gradient could then be explained if two assumptions are made. First, that pressure on land resources is directly and linearly correlated with population density. The second assumption is that the natural biological productivity of the drylands is negatively correlated with sensitivity to human pressure.

Given these two assumptions, the data of productivity and population density presented in Fig. 6 suggest that while sensitivity to pressure increases with aridity (meaning that areas of low natural productivity would be more sensitive to human pressure on the land than areas of high natural productivity) population density exponentially increases with declining aridity (meaning that people prefer to settle in areas of lower than of higher aridity). It can then be proposed that in the driest dryland sensitivity is highest but pressure is lowest and in the least dry dryland sensitivity is lowest but pressure is highest. Hence in both extremes of the aridity gradient desertification will be lower than in areas of intermediate aridity, where both pressure and sensitivity are intermediate. To conclude, the data support the hypothesis that desertification is driven by an interaction of ecosystem sensitivity (expressed by its inherent natural biological productivity) and the pressure exerted by people on land resources (expressed by population density), when striving to increase biological productivity to levels above its inherently low values in the drylands.

Most interesting is that infant mortality rates, an indicator of reduced human well-being, as function of aridity follows that of desertification as a function of aridity (Fig. 6). This can be interpreted in two, non-exclusive ways. Either the inherently low biological productivity fails to amply support a high and growing human population, or the pressure exerted by the population further reduces the natural productivity (i.e., the land becomes degraded and productivity becomes persistently lower), thus the reduced human well-being is driven by desertification. The first

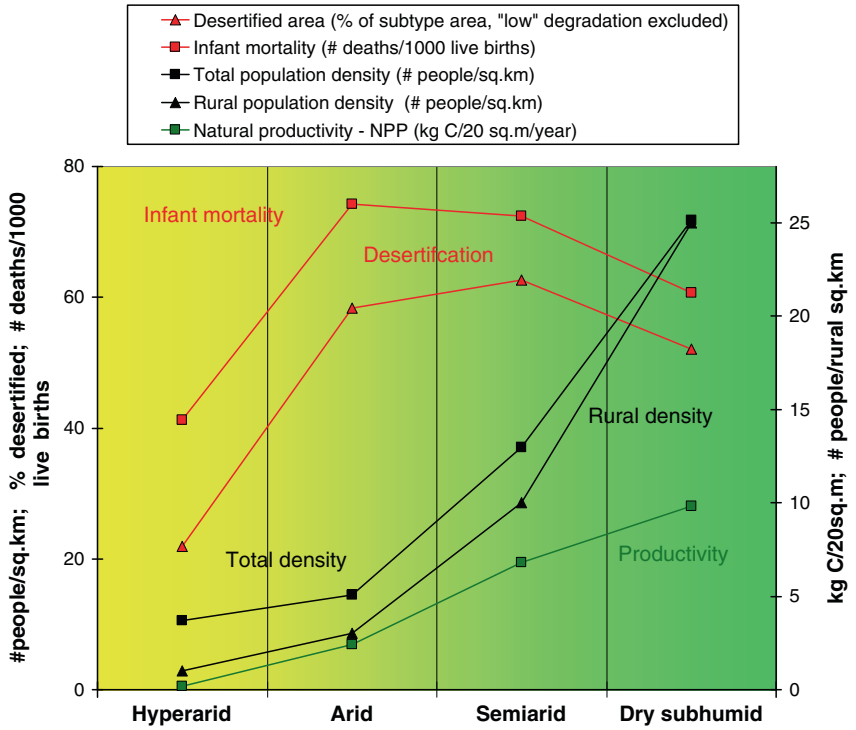


**Fig. 6** Dryland trends across the aridity gradient highlight apparent drivers and impacts of desertification. Desertification may be driven by the interaction of human pressure presented as rural population density (scale of right ordinate) and total density (scale of left ordinate) with ecosystem sensitivity to pressure which is the reciprocal of natural biological productivity (expressed by Net Primary Productivity, NPP, scale on right ordinate). Note that while the proposed drivers of desertification, sensitivity and population density are linear and exponential functions of aridity, respectively, both the spatial extent of desertification as well as the magnitude of infant mortality rates (an indicator of desertification impact) peak at intermediate aridity (data from MA, 2005 and analysis follows Safriel and Adeel, 2005)

scenario of reduced human well-being does not invoke desertification, but both scenarios can represent a continuum. Namely, human well-being is first impacted by the combination of low natural productivity and human pressure, and when pressure continues to be exerted and/or it is further mounting, desertification emerges, and further reduces human well-being. To conclude, observations of dryland trends across the aridity gradient provide evidence for human and natural factors interacting as drivers of desertification, and for desertification acting as a driver of low human well-being. Nevertheless, though the mechanisms linking human actions to desertification and desertification to human well-being are not yet well understood, these phenomena can be described as a paradigm, deeply rooted in the current political discourse.

## Desertification Paradigm, Environmental Security Narrative and the Dryland Livelihood Counter Paradigm

In the Desertification Paradigm demographic, social, economic and policy processes lead to pressure on the land to increase its naturally low productivity, and these "indirect" human-activity drivers result in soil erosion and/or salinisation, the major "direct", biophysical drivers of desertification, expressed in an eventual reduction of productivity, to down below its potential, natural levels. The immediate impact of this desertification is reduced human well-being, that drive people to further increase the pressure to make up for the reduced productivity, which only exacerbates rather than improves the situation. This brings about a further reduction in human well-being, expressed in interlinked poverty, migration and even famine. These combined often feed back on the human-related indirect drivers that impinge on the direct drivers of desertification, what further exacerbates the pressure on the resources. Thus, the Paradigm is that of a downward spiral of desertification, being ever exacerbated by two nested self-reinforcing positive feedback loops (Fig. 7a, left).

The Desertification Paradigm is augmented by an Environmental Security Narrative (Fig. 7a, right). This Narrative specifically addresses the demographic indirect drivers as population growth which creates a "demand-induced environmental scarcity" (Homer-Dixon, 1994), which in the desertification context translates to scarcity of biological productivity resources (Safriel and Adeel, 2008). The socio-political indirect drivers, according to the Environmental Security Narrative, lead to an unequal resource access, addressed as "structural environmental scarcity". It is only the persistent reduction of the environmental resource, namely desertification, which creates a "supply-induced" environmental scarcity. This environmental scarcity can be equated with "reduced environmental security", also expressed in reduced human well-being that encourages migrations and refugees, often interacting with famines and pestilence. These combined breed conflicts and even violence, that feed back to increase rates of migration and further reduction of overall human well-being. Thus, the Environmental Security Narrative encompasses additional feedback loops that reinforce the Desertification Paradigm (Fig. 7a).

There are claims and some evidence, however, that increasing pressure on dryland resources need not end up in reduced human well-being, whether driven by desertification, or merely by the highly demanding natural conditions of the drylands (Safriel and Adeel, 2008). This alternative development pathway in the drylands is too of a paradigm status – the desertification Counter Paradigm (Fig. 7b). It suggests that population growth and its resulting increased impact of land users on the inherently low biological productivity of their land, challenges the land users, in a way that induces their inherent ingenuity. This induced ingenuity translates into adaptations and innovations that promote rather than impact biological productivity, thus allowing for the maintenance of acceptable or even improved human well-being. The induced ingenuity and innovations can be triggered by the increasing demand for agricultural products stimulated by the growing population (Boserup, 1965). Thus, the innovations and adaptations are not only technical or even technological

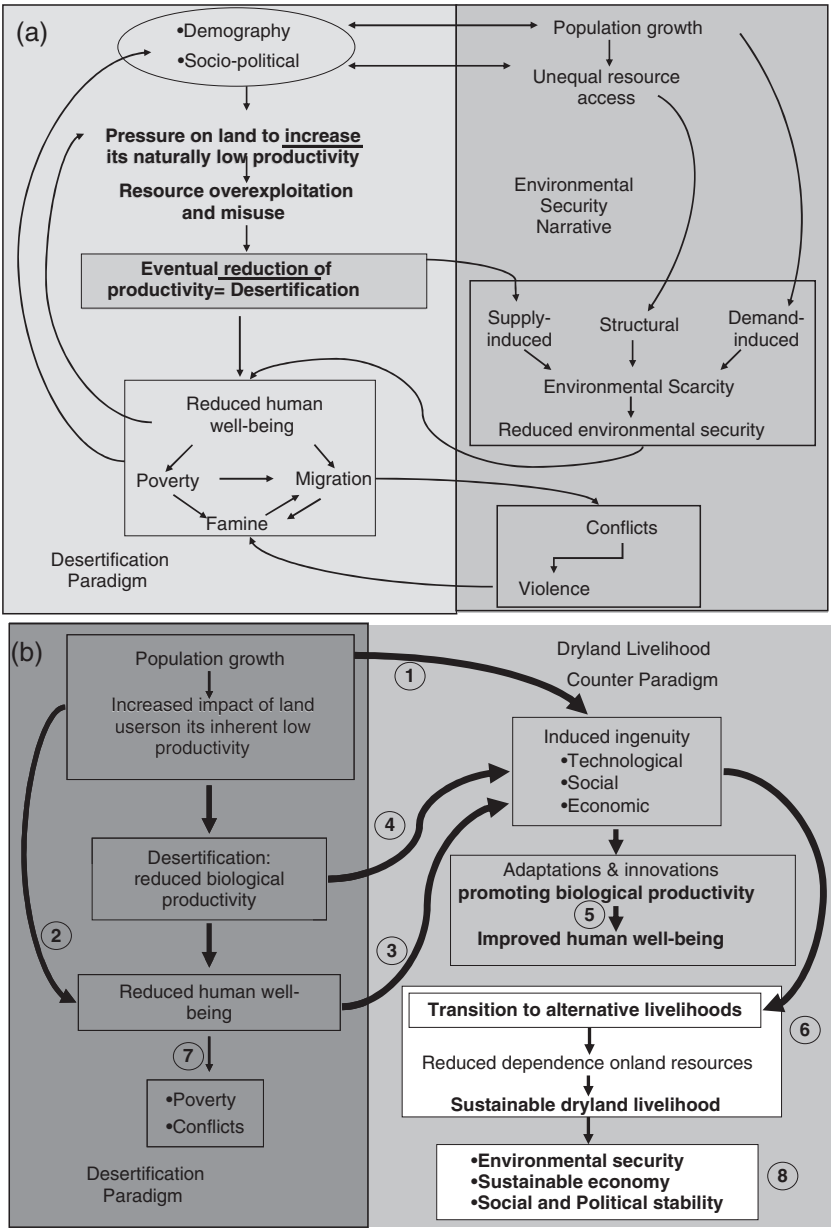


**Fig. 7** Three views of desertification. (**a**) Desertification in the "Desertification Paradigm" (*left*) is exacerbated by the "Environmental Security Narrative" and (**b**) the "Desertification Paradigm" can be replaced by its counter paradigm, the "Dryland Livelihood Paradigm" in which the downward spiral leading to desertification is disrupted and dryland livelihoods, including alternative ones, lead to a sustainable land use in the drylands. For *circled numerals* see text (schemes adapted from Adeel et al., 2005 and Safriel and Adeel, 2008)

(Adeel and Safriel, 2008), but they include social innovations involving labor management (Tiffen et al., 1994), and socio-economic innovations associated with local informal institutions (Mazzucato and Niemeijer, 2002) such as developing marketing infrastructures and financial mechanism for accessing and utilising the emerging markets.

It is not always clear what precisely is the trigger of the induced innovation, proposed by the Counter Paradigm. Local land users may be challenged already by population growth alone (arrow 1 in Fig. 7b), or only when their human well-being declines, and this either due to the demand-induced resource scarcity (arrows 2 and 3) or due to a supply-induced scarcity resulting from desertification (arrow 4). The latter is exemplified by cases of increasing degradation of the land in Africa, driven by pastoral land use of an increasing population, but followed by recovery as the dense human population created markets for agricultural products, which stimulated land rehabilitation (Tiffen and Bunch, 2002). Similarly, cases have been reported of population growth leading to land scarcity, driving some land users to leave their land and become workers in others' lands, what enabled the latter intensification apparently leading to sustainable increased productivity (Reij et al., 1996). One way or another, according to the "induced ingenuity" Counter Paradigm, the innovations leads to a promotion of biological productivity and improved human well-being (arrow 5).

However, as long as the induced ingenuity does not lead to reduced population growth rate at some point in time, promotion of biological productivity would inevitably come to an end, and the adaptive capacity and ingenuity to overcome the natural conditions of the drylands would be exhausted at some threshold level of resource use. This may happen earlier than might be expected as pressure on the global marginal lands, most of which are in the drylands, is predicted to mount when all globally available good cultivable land would not suffice for providing the global nutritional needs (Safriel and Adeel, 2008).

The assessment is therefore, that even when the "induced innovation" counter paradigm development track prevails, the prospects of long-term for agriculture in the drylands are not good, and sustainability is not guaranteed. Therefore land users' ingenuity and adaptive capacity need to take a different trajectory before land use in the drylands becomes unsustainable. This trajectory, for example, may be turning to livelihood options that are not dependent on land resources (Homer-Dixon, 1994), or at least reducing their dependence on land (Matthiew et al., 2003). These are the "alternative livelihoods" (Safriel and Adeel, 2005; Safriel, 2006; Adeel and Safriel, 2008) that mostly capitalize on non-agricultural dryland assets (arrow 6 in Fig. 7b), such as tourism and solar energy production, but also aquaculture (Adeel and Safriel, 2008) and afforestation, that counter-intuitively are more water efficient and economically profitable, and less land degrading than conventional agriculture in the drylands.

The gradual adoption of dryland alternative livelihoods transforms the "induced ingenuity/innovation" counter paradigm into the "Dryland Livelihood Counter Paradigm" of desertification. Accordingly, the reduced human well-being leading to loss of environmental security, poverty and conflicts under the Desertification

Paradigm scheme (arrow 7), either independently or combined with the attained sustainable use of biological productivity under the "induced innovation" track can be avoided; alternative dryland livelihoods may lead to a sustainable economy, one which maintains the natural resource base, yet allows for growth through improvements of knowledge, organization, governance and technical efficiency, promoting environmental security and political stability (box 8 in Fig. 7b).

To conclude, a number of cases supporting either the Desertification Paradigm or its counter paradigm have been reported, and it has been suggested that the prevalence of each of these dryland development pathways depends on societies' adaptability to population growth as well as to globalization, market development, technological change, climate change, and agro-ecological conditions (OASIS, 2006). This also applies to the Mediterranean regions, to be discussed in the following sections.

## Mediterranean Desertification

### *Attributes of Mediterranean Regions*

"Mediterranean" is not only a name of a geographical region, the "Mediterranean Basin", but it is a climatic term. Namely, not only the Mediterranean Basin, but also other four regions on the globe, in California, Chile, South Africa and Australia experience a Mediterranean climate (Fig. 8). The unifying features of the global Mediterranean regions (that combined comprise at most 1% of the global land) are both geographic and climatic. Geographically, all constitute a narrow strip of land (on a continental scale), with one edge bordering an ocean front and the other borders ecosystems that are either drier or wetter than the Mediterranean ones. Climatically, their rainfall is restricted to one, relatively short season which is a disadvantage for biological productivity. But, this season is winter, which means that

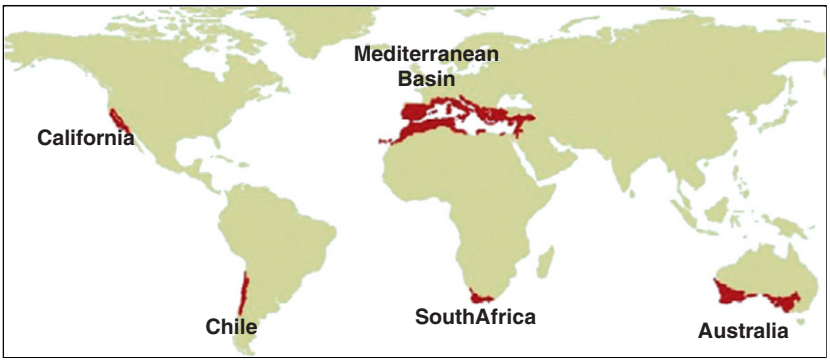


**Fig. 8** The Mediterranean climate regions of the world (adapted from Aschmann, 1973)

even though overall annual rainfall is relatively low, evaporative losses during the rainy season are low, allowing a large proportion of the rainfall water to penetrate into relatively deep soil horizons, to become protected from high evaporative losses during the dry season, during which no rainfall occurs. A feature common to all Mediterranean regions but is shared with some other ecosystems is that their aridity index places them with other ecosystems of the semiarid and dry-subhumid climates (Safriel and Adeel, 2005). Another such feature is that both their proximity to the ocean, which generates a strong climate–topography interactions, and their narrow spatial configuration that brings much of their area into contact with and proximity to other ecosystems, endows the Mediterranean ecosystems with a relatively rich biodiversity.

The Mediterranean Basin differs geographically from all other Mediterranean regions in that it constitutes a narrow strip along the coasts of a nearly land-locked sea, adjacent to and connected with an ocean. More importantly, it is also endowed with high diversity of soil-types creating local spatial mosaics, what also contributes to rich local soil and biological diversities. Finally, the Mediterranean Basin's lands are of very long history of intensive use by man, apparently longer and more intensive than that of the other Mediterranean regions of the world. This feature confers unique adaptations to several components of the Basin's biodiversity, and some characteristic features to the structure and function of its ecosystems, especially with respect to their responses to human impact, including grazing, cultivation and fires (e.g. Naveh, 1990, 1991). Furthermore, meteorological studies suggest that the land use changes in the Mediterranean Basin, accumulated over historical time and much accelerated during the last 30 years may have induced climatic change expressed in intensified winter rains and floods (Millán et al., 2005).

## *Drylands and Desertification in the Mediterranean Basin*

Comparison of the map of the spatial extent of the Mediterranean climate within the Mediterranean Basin with the map of the Mediterranean Basin's drylands (Fig. 9a, b) shows that most areas of a Mediterranean climate are also drylands, though some areas of a Mediterranean climate are not drylands (e.g. areas in Mediterranean France and in southwest Turkey), and some Mediterranean drylands do not have Mediterranean climate (e.g. Mediterranean Libya). It is evident, though, that the northern, or the European Mediterranean differs from the southern, or the African Mediterranean in that the leeward fringes of the northern Mediterranean are adjacent to non-drylands, whereas the leeward fringes of the southern Mediterranean are adjacent to desert drylands. Also, most northern Mediterranean drylands are non-desert drylands (semiarid and dry-subhumid) whereas most southern Mediterranean drylands are desert ones (many arid but also some hyperarid ones, adjacent to the sea front, Fig. 9b). Thus, the southern Mediterranean is drier than the northern Mediterranean. Note however, that large areas of both the northern and the southern Mediterranean are semiarid drylands (Fig. 9b).

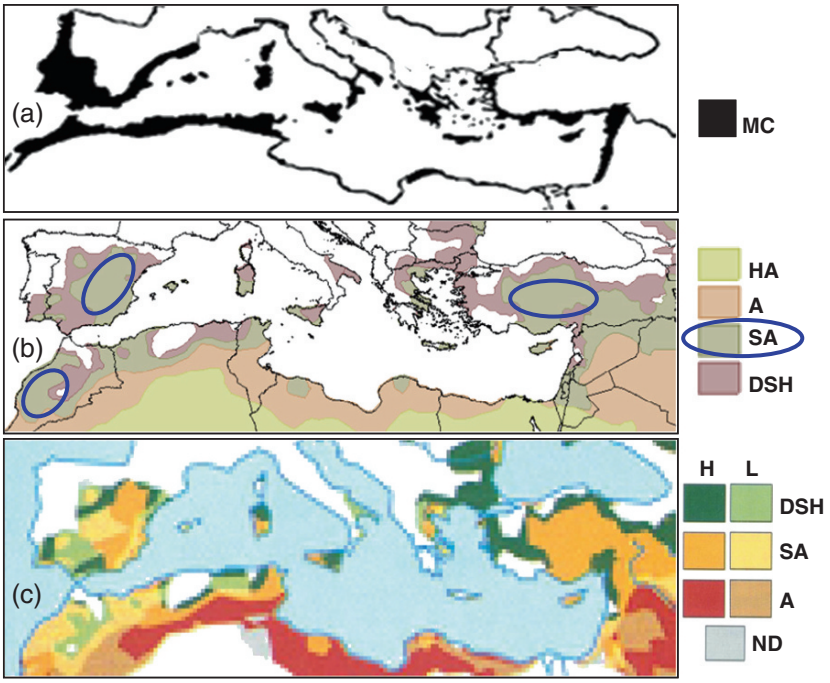


**Fig. 9** The Mediterranean Basin. (**a**) The extent of the Mediterranean Climate (MC) (adapted from Aschmann, 1973). (**b**) The Mediterranean drylands (HA – hyperarid, A – arid, SA – semiarid, DSH – dry-subhumid), *blue circles* – areas of large extent of semiarid drylands, in Spain, Morocco and Turkey, adapted from the Millennium Ecosystem Assessment Core Database, and (**c**) "Desertification severity" in the Mediterranean drylands [H – high and very high degradation, L – low and medium degradation, in dry-subhumid (DSH), semiarid (SA) and arid (A) drylands, ND stands for non degraded drylands] (from World Atlas of Desertification, Middleton and Thomas, 1997)

Recalling Fig. 6, demonstrating that at the global scale the semiarid drylands are most prone to desertification, it is expected that desertification would be relatively prevalent the Mediterranean Basin where semiarid regions prevail, in which soil erosion is high since rainfall is sufficiently high to generate surface runoff yet this rainfall is insufficient to maintain plant cover effective in arresting the runoff (Thornes, 1999a). Indeed, most drylands of the Mediterranean Basin are desertified (Fig. 9c), and many of them severely so, especially the semiarid ones, but more so in the northern than in the southern parts of the Basin (compare the circled areas in Fig. 9b with same areas in Fig. 9c). Available estimates of desertification, for example, are 30% of the semiarid Mediterranean drylands, 65% of European drylands, and 10% of Europe (Rubio and Recatala, 2006). A salient example is that of the Guadalentin Basin, in Murcia, Spain (Lopez-Bermudez et al., 1998). In this $3,300\,km^2$ of dryland basin, half of which is semiarid dryland (Fig. 10) and 31% and 29% of it have been used as rangelands and rainfed agriculture, respectively, only 15% of the land were free of soil erosion or demonstrated only slight sheet erosion, while the rest of the basin suffered from various degrees of severe soil erosion

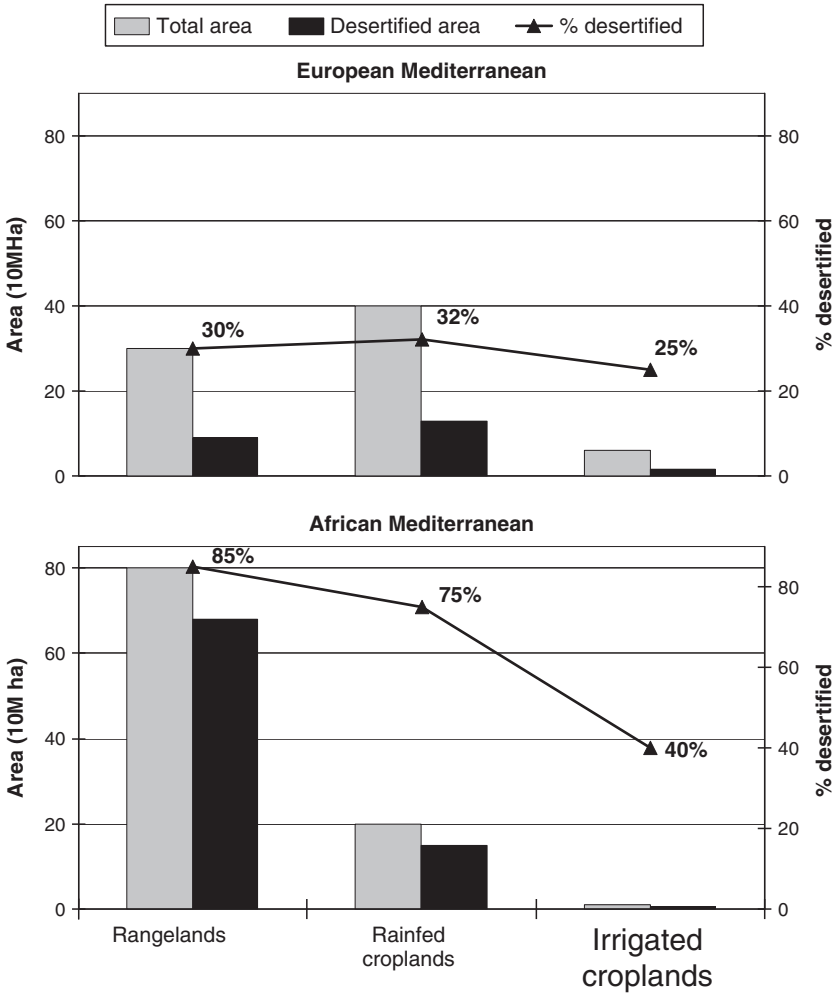


**Fig. 10** A case of severe desertification in the northern Mediterranean Basin – the Guadalentin Basin, Murcia, Spain. Desertification is expressed in soil erosion (*bottom*). Data from Lopez-Bermudez et al. (1998)

(Fig. 10 bottom). Whereas traditional agriculture persisted in this basin until the 1970s, its subsequent intensification is implicated with the severe erosion, that in the 1990s resulted in soil loss ranging between 100 and 250 t/ha/year (from 15% of the basin) to over 250 t/ha/year (from 2% of the basin, Lopez-Bermudez et al., 1998).

There is also a difference between the western and the eastern Mediterranean Basin, the latter is drier than the former (Fig. 9b), yet desertification seems to be similarly prevalent in both (Fig. 9c). However, the desertification in Fig. 9c is the "degradation severity" of GLASOD, which is exaggerated being a combination of "degradation degree" and "degradation extent" (Middleton and Thomas, 1997),

**Table 1** Land degradation (most of it desertification) statistics of Mediterranean agricultural land in the early 1980s (adapted from Correia, 1999; based on Gleick, 1993)

| | Area ($10^6$ ha) | | Degraded % | # People (Millions) Affected by Degradation | | Total # People Affected | % of People Affected by Severe Degradation |
|---|---|---|---|---|---|---|---|
| | Total | Degraded | | Moderate | Severe | | |
| Mediterranean Basin | 177 | 107 | 60 | 32.5 | 14.5 | 47.0 | 31 |
| European Mediterranean | 76 | 23 | 30 | 16.5 | 6.0 | 22.5 | 27 |
| African Mediterranean | 101 | 84 | 83 | 16.0 | 8.5 | 24.5 | 35 |

resulting in a frequent mismatch between sampling units and mapping units (see Safriel, 2007). Thus, just as with global desertification, it is still difficult precisely to assess the spatial extent of desertification in the Mediterranean Basin, and different assessments are likely to come up with different values.

For example, a survey of the pastoral and agricultural lands of the "Mediterranean region" (i.e. not necessarily just drylands, Correia, 1999) yielded somewhat modest dimensions of land degradation in the late 1980s (Table 1): 60% of these lands were degraded, but most of this degradation is contributed by the southern, African areas (degradation of only 83% of used land, compared with 30% of the northern, European lands degraded). Furthermore, of the 45 million people that were then affected by land degradation (most were probably in the Mediterranean drylands, hence affected by desertification), 31% were affected by severe degradation, a proportion to which the African drylands contributed more than the European ones (severe degradation affected 36% of degradation-affected inhabitants of African lands, as compared to European figure of 27% only, Table 1).

## *Drivers of Mediterranean Desertification*

The Correia (1999) survey also attempted to relate degradation to land use types, and demonstrated that degradation was the lowest in irrigated croplands, as compared with rainfed ones and with rangelands, in both the European and the African areas (Fig. 11). But though the overall African irrigated area was smaller than that of the European one, its degradation was higher (40% of African degradation vs. 25% degradation in the European irrigated lands). By the same token the most common land use in the African areas was the pastoral, demonstrating the highest degradation level compared to the whole Mediterranean basin (85% of African rangelands degraded). In the European lands the rainfed cultivation was the most common land use, with the highest degradation (32%) compared to that of the other European land uses (Fig. 11). It can be therefore concluded that in the Mediterranean Basin

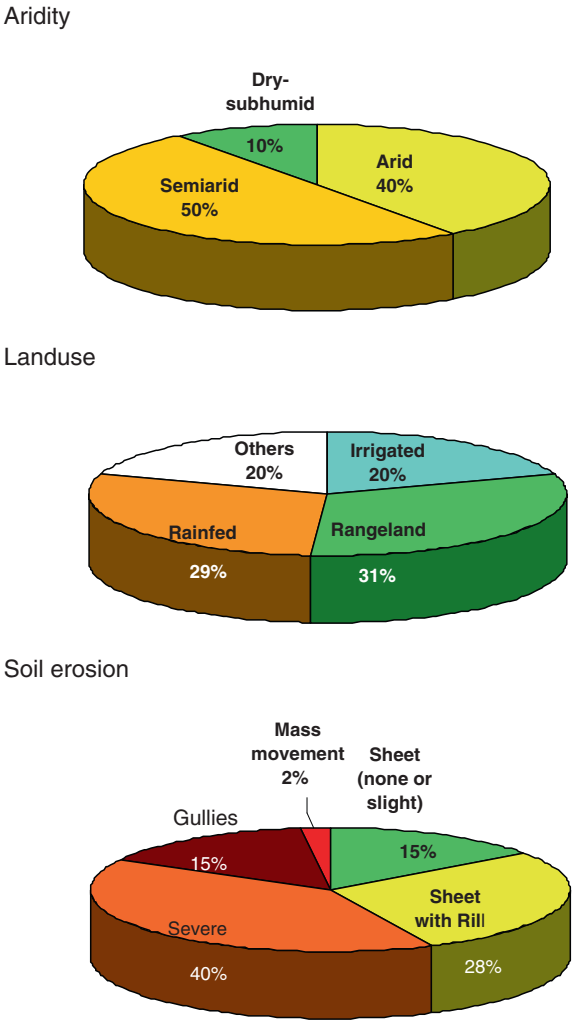


**Fig. 11** Land-use dependent land degradation (mostly but not only in drylands) in the rural areas of the European (*top*) and the African (*bottom*) regions of the Mediterranean Basin in the early 1980s (adapted from Correia, 1999, based on Gleick, 1993)

the land that is most extensively used is also most intensively used, leading to it becoming also most degraded, whereas the mode of use, whether grazing, rainfed, or irrigated cultivation may be of lower significance with respect to degradation risk.

Indeed, a comparison between the northern and the southern drylands in the western Mediterranean Basin (Puigdefábregas[a] and Mendizabal, 1998) revealed that whereas in the northern (Maghreb) countries rangelands have been recently degraded by overgrazing and encroachment of cultivation, in northern Mediterranean countries the relatively recent increase in irrigated cultivation at the expense of

rainfed irrigation took place. This rapid increase in extent was associated with an intensified impact, making irrigated agriculture "a hotspot of desertification", expressed in on-site salinisation and off-site degradation of aquifers and wetlands. In both the northern and the southern Mediterranean one of the desertification drivers was overstocking the rangelands with sheep. The two regions, however, differed in that the northern Mediterranean desertification was driven by new irrigation developments and expansion of traditional tree crops over marginal lands, both (as well as the sheep overstocking) driven by markets and regional agricultural policies, whereas in the southern Mediterranean the additional major driver have been encroachment of cultivation on rangelands, being driven (together with the sheep overstocking) by population growth and national agricultural policies, on sedentarisation and food security (Mendizábal and Puigdefábregas, 2003).

## The Resilience of Mediterranean Ecosystems and Their Desertification Threshold

The drivers of Mediterranean desertification are basically similar to those driving desertification elsewhere in the global drylands. However, in spite of the Mediterranean high climatic unpredictability and unstable soils, the long history of overgrazing and human-induced fires resulted in a degree of resilience of the Mediterranean drylands to human impact. As elsewhere, also in the Mediterranean, the resilience is endowed by both the physical–chemical properties of the soil on the one hand and the ecological properties of the Mediterranean biodiversity, as expressed in the degree and nature of the soil's vegetation cover, on the other hand. The vegetation cover mitigates the erosive pressures that reduce the soil's potential to support the vegetation. Thus, as soil erodes its ability to sustain the vegetation is reduced, and as vegetation cover is reduced, soil erosion rates increase, and the ability of the soil to support its own protective vegetation cover is reduced too.

However, observations that erosion sharply drops only when vegetation cover is greater than a certain level (40% cover, in many locations, Yassoglou, 1999), suggest that the soil-vegetation system in the Mediterranean Basin is resilient to a mutually mounting pressure, up to a point in which a threshold is crossed. This notion is captured by a conceptual, graphic model, in which vegetation state (expressed by increasing amount of vegetation cover) and soil state (expressed by reduced value to vegetation due to increasing erosion) are represented by a two-dimensional axes system, on which the theoretical zero-isoclines of each of the two simultaneously interacting variable are plotted (Fig. 12). The isoclines' shape and positioning reflect the assumption that certain pressures on vegetation (such as grazing or firewood collection) reduce its cover, and this increases soil erosion, yet the slightly eroded soil still supports the vegetation cover. Removal of the pressure may then restore vegetation cover, and even soil functions. The system can thus move, depending on pressure, between a stable state of no degradation (full vegetation cover and no soil erosion) and an unstable equilibrium in which both vegetation cover and soil are degraded, yet their degraded states are stable. This equilibrium is unstable since

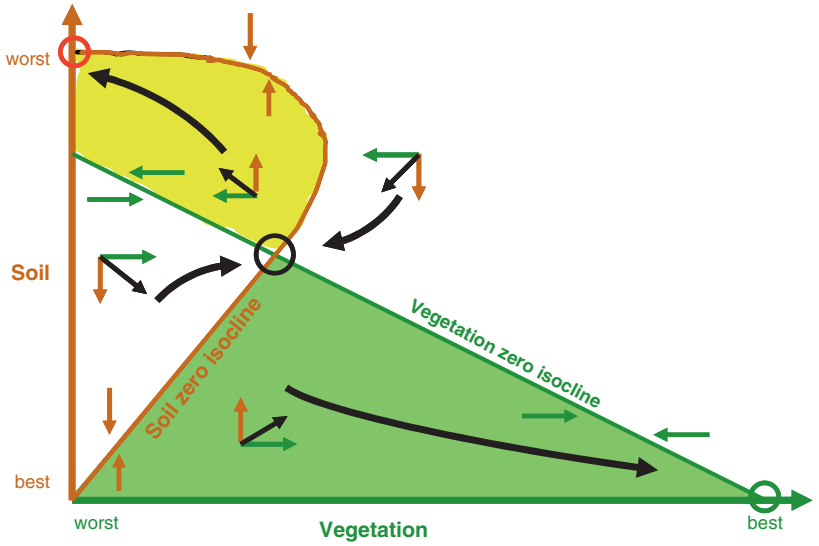


**Fig. 12** A resilience – desertification threshold model, based on soil erosion–vegetation cover interactions in the Mediterranean Basin. Ordinate: soil state with respect to erosion, progressing from best state (*bottom*, no soil erosion) to worst state (*top*, soil after severe erosion); abscissa: vegetation state with respect to soil cover, progressing from left (worst state, virtually no cover), to the right (best possible cover). *Lines* – zero isoclines, along which there is no change. *Green arrows* – direction of vegetation cover change; *brown arrows* – direction of soils state (reciprocal of soil erosion) change, and *straight black arrows* – the resultant direction of change taken by the interacting vegetation and soil states. *Curved arrows* – overall direction of change of the vegetation-soil system: *Green area* – the system's resilience, all combinations of vegetation and soil states of values within this area converge upon a stable state of best soil state (no erosion) and best vegetation cover; *black circle* – All combinations to the right and left converge upon this value of the soil-vegetation system that represents an unstable equilibrium, or a desertification threshold – the system can be driven into the green area and regain a stable state of soil conservation and vegetation productivity (*green circle*), or into the yellow area, moving towards stable desertification state (*red circle*), with severely degraded soil and virtually no vegetation cover (adapted from Yassoglou, 1999, based on Thornes, 1988)

random or external drivers can deflect the system from this unstable equilibrium point on the two-dimensional space, either towards the positive, stable state of full restoration, or it will pass the threshold and move into a region of runaway mutual degradation (the yellow regions in Fig. 12).

These increasing rates of vegetation loss due to increased erosion, or increasing erosion rates due to intensified vegetation loss, terminate in virtually no vegetation cover, and extreme soil degradation – a stable, irreversible state of degradation, i.e. desertification (in the narrow sense of the term). This state however, cannot be reversed by the land and vegetation inherent properties, though human intervention, depending on investments, may restore the system (Yassoglou, 1999). Most importantly, the position of the desertification threshold is bound to vary within the Mediterranean basin depending on local climate, soil, and vegetation properties,

all interacting with the variety of human-induced pressures. Though further modeling efforts for elucidating and predicting Mediterranean soil erosion are available (Rubio and Recatala, 2006), the validation of the desertification threshold model, and the diverse human-induced impacts that interact with its biophysical variables, remains an exciting arena for future research of Mediterranean land degradation and desertification.

Some studies of the latter interactions are already available. For example, increased aridity is expected to exacerbate soil erosion, but studies in Spain and in Crete found highest erosion rates in the least dry drylands (Boix et al., 1998). This is because the relatively high productivity of these Mediterranean drylands attracts its exploitation, whose apparent excess encourages soil erosion, driven by overgrazing (in Crete) and fires (in Spain). Where in such least dry drylands grazing is removed and fire risk is suppressed, soil erosion is much lower than of drier drylands (in Israel).

Desertification through overgrazing and fires is common in the northern and eastern Mediterranean Basin's dry-subhumid and semiarid drylands, but these can be managed in ways that control desertification. The vegetation of these drylands is mostly typical "Mediterranean", of two distinct plant communities – one is of perennial sclerophyllous shrubs and drought-resistant shrubs, and the other is that of a high diversity of annual plant species, dominating the landscape with greenery and flowers in the rainy season, and with a yellow-brown standing-dead cover during the dry season. These two distinct communities are habitually used as range, and each of them is potentially replaceable by the other, depending on the mode of this human use. Grazing combined with fire drive the replacement of the perennial by the annual community. Where grazing and fire intensify this replacement becomes permanent, what increases the risks of soil erosion in these areas. Also, when grazing and fire are increasingly suppressed, the annual community is replaced by the perennial one and a lengthy persistence of the perennial community, from which most annuals will be excluded, reduces the quality of the soil and makes it more prone to degradation. The appropriate management for maintaining soil qualities and reducing desertification risks in these rangelands is that of encouraging the historical prevalence of a spatio-temporal mosaic of distinct annual and perennial Mediterranean vegetation patches (Clark et al., 1998). This can be achieved through controlling grazing and fire at moderate levels, and moving these controls adaptively and dynamically between patches. In addition, even where degradation has been initiated, due to the resilience properties of these two communities, rehabilitation of each is feasible by adaptively changing the grazing impact (Radogou, 1999). It was also suggested (Thornes, 1999b) in spite of severe degradation, the Mediterranean vegetation can be naturally recovered such that it's potential to arrest soil erosion is restored. This would take some 8–10 years, while recovery of aquifer recharge through restored vegetation cover would take longer, as much as 40–50 years.

## *Afforestation as a Measure of Controlling Mediterranean Desertification*

Through its long history of land use, an increasing Mediterranean area of dryland woodlands has been transformed to rangelands and croplands, especially in the northern and eastern parts of the Basin. Also through the long human history in the Basin, such croplands and rangelands have been abandoned, either due to political vicissitudes or as a result of desertification. Yet, apparently due to the long history of persistent cultivation and grazing, woodlands have not been re-established in the abandoned lands. And though the Israelites were instructed to plant trees upon returning from Egypt to their abandoned drylands (Leviticus 19:23), afforestation as a means of restoration of degraded land have become a widespread Mediterranean practice only relatively recently.

The most common species used in many afforestation projects is the Aleppo Pine *Pinus halepensis*, a Mediterranean species of the pioneering life history trait, with relatively fast growth and short life span, as compared to most other indigenous Mediterranean trees. Research carried out following decades of this practice addressed the effect of this significant ecological change in large area of the Mediterranean drylands. Most studies to date revealed a negative effect on water balance and on the recovery of indigenous shrub species, as well as low recovery of soil structure and enhanced runoff and soil erosion, as compared to areas afforested with other species (Maestre et al., 2003). In studied cases of *P. halepensis* afforestation with existing indigenous Mediterranean species aimed at expediting the recovery of the natural woodland in south-east Spain, the aspired positive effect did not materialize. On the contrary, a negative effect on the indigenous shrub species' physiology was detected, mainly due to competition on water (Bellot et al., 2004). Furthermore, experiments demonstrated that even the changes in under storey microclimatic conditions brought about by afforestation with the pines, have been insufficient for facilitating the establishment of major indigenous Mediterranean woodlands' shrubs (Maestre and Cortina, 2004).

Most of these studies have been conducted in semiarid areas, in the western Mediterranean. In the eastern Mediterranean dry-subhumid and semiarid afforestation with *P. halepensis* in potential woodland ecosystems, restoration of the degraded indigenous woodland is regarded as successful, depending on availability of natural seed sources. The effect of such afforestation on soil erosion was studied in Israel but in a dryer region compared to most other areas where afforestation of *P. halepensis* took place. This is the transition between semiarid to arid areas, where no natural woodland have been ever present, but the natural rangeland there had been grazed for generations, leading to some soil erosion. The studies revealed that though as much as 94% of the rainfall is not intercepted by the pines' canopies but impacts the soil surface this rainfall water does not generate runoff. Rather, rainwater is redistributed through mostly subsurface movement (Shachanovitch et al., 2008), such that only 3% of the rainfall becomes surface runoff, and none of it escapes the afforested watershed in flash floods and hence soil erosion in the watershed is

negligible. Furthermore, since the trees were found to transpire 60% of the rainfall, 40% remained available to wild indigenous vegetation within the forest.

Thus, at least in this case dryland afforestation in an eastern Mediterranean Basin site was found to be instrumental in soil conservation, and in controlling destructive and wasteful flash floods. The cost however, was of reducing indigenous non-woody biodiversity. The productivity of indigenous annual plants was reduced by 48% and that of perennial shrubs by 93%, as compared to non-grazed and non-afforested parts of the region. A controlled field experiment carried out in the forest demonstrated that arboreal and herbaceous vegetative cover both reduce runoff and increase soil moisture, and that mixed arboreal–herbaceous cover is slightly more effective in doing so. The finding led to the conclusion that sustainable rangeland management is likely to be as effective in soil and water conservation as replacing rangeland with forest, though the combination of planted trees and indigenous flora is likely to prove most effective. Another interesting finding of this study (ICARDA, 2007) is that the Mediterranean floral component (annual plants and perennial shrubs) in the local vegetation (that includes also Asian and Saharan elements), increased due to this *P. halepensis* afforestation. Finally, Mediterranean afforestation may become significant in the context of global climate change and its expression in the Mediterranean Basin.

## Climate Change and Mediterranean Desertification

### *Climatic Projections for the Mediterranean Basin*

One of the projected regional impacts of global climate change is elevated temperatures associated with increased evaporation (and transpiration) and reduced precipitation in the drylands (Meehl and Stocker, 2007). These global projections are also valid for the Mediterranean Basin. Warming (Fig. 13a) is very likely to be larger than the global annual (3°C–5°C increase is expected during the period 2071–2100 in the drier, eastern section of the Basin, Dayan and Koch, 1999). Furthermore, the largest warming is likely to be in the summer (Christensen and Hewitson, 2007a), thus resulting in overall high evaporative losses. On top of it, whereas global warming will bring about increased precipitation in many areas, this will not happen in the Mediterranean Basin (Fig. 13b), and annual precipitation is very likely to decrease in most of its areas. In more detail, annual number of precipitation days is very likely to decrease thus dry spells will increase in length and frequency, and risk of summer drought is likely to increase too (Christensen and Hewitson, 2007a). In the eastern section of the Basin, for example, precipitation is projected to be 40% lower during 2070–2079, than it observed value during 1961–1970, with 2–3 times increase in the frequency of intense storms, of 70 mm/day (Alpert et al., 2002). Synthesizing these projections, the Mediterranean Basin is expected to suffer an overall decrease in water resources (IPCC, 2007).

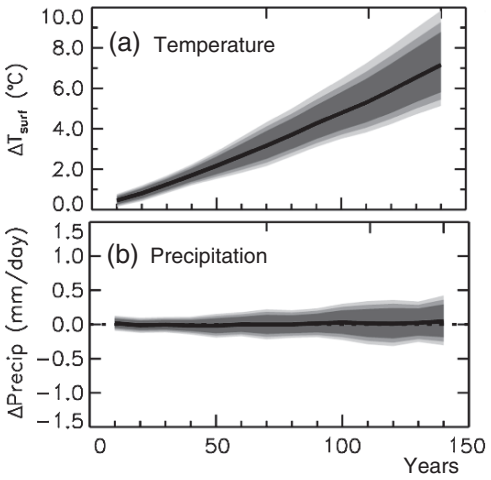


**Fig. 13** Climate change projection for the Mediterranean Basin, for the first 150 years of the 21st century relative to year 2000, given a 1% annual increase in $CO_2$ atmospheric concentration (medians, with 95%, 90% and 80% confidence ranges). (**a**) Surface temperature increase and (**b**) change in millimeter precipitation per day (Christensen and Hewitson, 2007b)

## *The Projected Impact of Climate Change on the Mediterranean Drylands*

The global aridity gradient, from hyperarid to dry-subhumid drylands can be described as a gradient of declining biological productivity relatively to that of non-drylands. Thus, the aridity gradient is expressed by a reduction in biological productivity at the global spatial scale, driven by spatially changing climate. Desertification, on the other hand, is a reduction of local productivity at the temporal scale, driven not by climate but mostly by human impact. However, the regional expression of the recent human-induced global climate change in the Mediterranean Basin region, may lead to an increase in the spatial extent of the Mediterranean drylands. For example, recall that desertification can reduce the productivity of a dry subhumid Mediterranean dryland to a level similar to that of an arid Mediterranean dryland, and this not due to change in climate but to change in land use. However, global climate change as expressed in a changed climate in the Mediterranean Basin can bring about a reduction in productivity of a Mediterranean dry subhumid dryland, down to the level of that of a semiarid dryland. This would not be termed "desertification" since it is driven just by climatic factor, with no on-site human impact, though the change in climate is driven by human activity, but mostly by humans off-site, and usually off the drylands. By the same token, climate change in the Mediterranean non-drylands is expected to change such that their climate becomes that of drylands.

Indeed, it has been projected that climate change would bring about a replacement of the semiarid vegetation by an arid one in many parts of the Mediterranean basin (Jeftic, 1993). One way of assessing this option is to explore the effect of recent Mediterranean climate change on the Mediterranean vegetation, the source of Mediterranean productivity. It is well established by now that global climate change has been already expressed in the regional Mediterranean Basin's climate during

the 20th century, through a 0.75°C rise in average annual temperature and through increased rainfall variability (Osborne et al., 2000). However, no clear signal of the Mediterranean vegetation response to this deterioration of climatic conditions has been so far detected. Modeling effort that dissociated the effect of rising temperature and increasing evaporation from the effect of increased level of atmospheric $CO_2$ on the productivity of major perennial shrub species common in the Mediterranean semiarid areas revealed that the climatic changes would have significantly reduced biological productivity. However, this expected reduction seems to have been offset by the positive effect of the increased atmospheric $CO_2$ concentration on productivity, which promotes photosynthetic activity, through increased water use efficiency (Osborne et al., 2000). This suggests that the lack of a clear Mediterranean vegetation signal to the regional effects of the global environmental change is not due to lack of response, but to a pronounced responses to both the detrimental change in climate, and to the ameliorating change in atmospheric $CO_2$. These two responses might have cancelled each other such that the effect of elevated carbon dioxide was stronger than that of elevated temperature. Or, the pressure on water availability exerted by the changed climate was compensated by the vegetation's water use efficiency, induced by elevated $CO_2$.

Another approach for assessing climate change projections is to trade temporal dynamic with spatial dynamics, namely, explore the change in vegetation response to change along a sharp aridity gradient. For example, the results of a field-experimental study along the aridity gradient within Israel demonstrated that the rate of change along the aridity gradient, from semiarid to arid drylands, of organic matter contents, soil aggregate size and stability, the sodium adsorption ratio and the runoff coefficient change is non-linear. Rather, a non-linearity, or a threshold exists at the transition between the two dryland types. This suggests that a relatively small climatic change would suffice to initiate a spatio-temporal transformation of the Mediterranean semiarid to arid drylands (Lavee et al., 1988).

## Attaining Environmental Security in the Mediterranean

### *Environmental Security and Desertification*

People not only used but apparently also impacted the Mediterranean drylands through millennia. Yet, like in all dryland as well as most other lands (MA, 2005), human-induced ecosystem transformations in the Mediterranean Basin and the resulting degradation of their services, mostly the service of biological productivity, were more intense during the last 50 years than during the previous 5,000 years (Thornes, 1999c). And, in-spite of a relatively recent increase in the abandonment of agricultural land and the increase in woody vegetation cover in many areas (both slowing down desertification trends) the prospects of climate change and mounting population size are likely to cancel out these recent positive developments. One way

of confronting current and future desertification risks in the Mediterranean basin is to address them as environmental security risks.

During the current and the last decade the concept of security has been expanded into national, societal, human and environmental "securities" whereby environmental security refers to ecosystem sustainability being risked by human activities (for discussion see Brauch et al., 2003). "Ecosystem sustainability" can be referred to as an ample provision of ecosystem services (*sensu* the Millennium Ecosystem Assessment, MA, 2005). Thus, when ecosystem services are degraded the "sustainability" of the ecosystem is at risk. And since desertification is "a result of a long-term failure to balance demand for and supply of ecosystem services in drylands", bringing about a "persistent, substantial reduction in the provision of ecosystem services" (Adeel et al., 2005), then desertification becomes a major environmental security issue in the drylands, those of the Mediterranean Basin included.

Desertification qualifies as an environmental security issue on several accounts. It is primarily a result of degrading biological productivity, thus risking food provision and hence it becomes a food security issue. This often leads to undernourishment, malnutrition, high vulnerability to disease, especially among children, thus making desertification a health security issue. Finally, when food security and health security are compromised, to the extent that they force people to leave their livelihoods, homes, and countries desertification becomes a livelihood security issue. This last expression of desertification as an environmental security issue inducing mass transboundary migrations often also triggers ethnic clashes and other conflicts. Thus, for example, only 28 of 485 conflicts registered in the Mediterranean Basin countries during the period 1975–2001 were attributed to drought and its resulting famine, but these affected 10.5 million people, which is about half of the 22 million people affected by conflicts driven by other causes (Brauch et al., 2003).

## *Desertification and Migration*

Desertification is habitually implicated for transboundary migration, though the direct linkage has not yet been determined quantitatively. Surely most migrants are driven by poverty and they originate in developing countries. Indeed, most drylands are in developing countries and desertification by definition occurs in drylands, and most poverty occurs in developing countries too. Yet the direct linkages between desertification and migration in the Mediterranean Basin require robust study. Though poverty and the risk of desertification may trigger migration from Mediterranean developing countries (e.g. Rubio and Recatala, 2006), globalization greatly facilitates this process. This is through the increasing unequal distribution of wealth among and within countries brought about by the constant growth of global economy, as well as due to the increased rate of information dissemination that provide both the push and the pull of the migration mechanism (Meyerson et al., 2007).

Much of the transboundary migration in the Mediterranean Basin is from dryland to non-dryland countries (e.g. from Turkey to Germany), and from dryland developing countries to dryland developed countries (e.g. from Morocco to Spain). However, a rigorous sectioning of the migrants with regard to sector (rural or urban) and land (dryland or non-dryland) is still required for implicating desertification. Also, it may be instructing to evaluate the short and the long-term benefits of migration, both to the recipient countries, and to the land and people left behind in the contributing countries, and weigh them against the negative aspects of the phenomenon. A confounding factor in this analysis is that a sizeable proportion of the migrant population in the Mediterranean Basin is from non-Mediterranean Basin countries (Baldwing-Edwards, 2004).

## *Development Paths in the Mediterranean That Promote Environmental Security*

Global climate change is not the only external source of a projected pressure on the Mediterranean land resources. Another external pressure is the projected appropriation of all good cultivable land on earth for food production, which is expected to take place by year 2050, when additional 4.5 million $km^2$ of same land quality will be required for feeding the global human population projected for that year. Attention will then be drawn to marginal lands, to be found by then only in the drylands (Safriel and Adeel, 2008). These two external pressures, combined with the two internal pressures of inherent low productivity and mounting population size may prove to be beyond the ability of handling by all measures to "combat desertification" through increasing land productivity. Thus, even if the current extent of desertification is relatively small and means to avoid it while promoting land productivity improve, an eventual widespread desertification leading to reduced human well-being, land desertion and migration can emerge, mainly in the semiarid drylands of the Mediterranean Basin. A way out would therefore be to explore now means of diversifying dryland livelihoods, such that the pressure on land resources is reduced yet dryland people opt to stay on their land.

One such option is that of dryland afforestation not just as a measure to arrest soil erosion (see previous section), but mostly for sequestering carbon, which can have a significant contribution to the global mitigation effort and hence can generate a new source of income, under the Clean Development Mechanism (CDM), and other carbon trading mechanisms of the outgoing Kyoto Protocol and the currently negotiated new international legal instruments under the United Nations Framework Convention on Climate Change. A salient example that this is an economically viable and environmentally sustainable option is that of Mexican dryland farmers who planted, and maintained forests for carbon sequestration and receive sizeable income from carbon contract, while these offset revenues are augmented by selling timber and agroforestry products (Lash, 2007).

Dryland afforestation can be more attractive for northern Mediterranean countries since most of their drylands are non-desert ones, and may have ample water resources to support afforestation, and yet would not highly compromise the land and water resources. But the people living in such drylands in the southern Mediterranean countries, most of which are developing countries, will be less resilient to the mounting desertification risks. Furthermore, the southern Mediterranean countries differ from the northern ones by having large areas of desert drylands (arid and hyperarid drylands). This however, may be an asset and paradoxically, the desert drylands of the southern Mediterranean offer opportunities rather than constitute a liability for their inhabitants. First, it is in the desert drylands that aquaculture is water-use efficient, economically profitable and environmentally sustainable, much more than desert agriculture (Safriel and Adeel, 2005; Safriel, 2006; Adeel and Safriel, 2008). Furthermore, the mounting thirst of humanity for alternative, non-polluting energy sources, due both to the mounting prices of fossil energy and to the need to reduce its use for mitigating global climate change, will generate very high premium for developing solar energy on a large commercial basis in deserts. For example, a Sahara Desert area of $320 \times 320$ km installed with solar collectors would provide all the annual electricity currently required by Europe (Warren, 2006). This is of course only an illustrative description of a potential, but it would provide the Maghreb countries of the southern Mediterranean with an excellent opportunity of becoming the provider of non-polluting electricity of the northern Mediterranean countries. Finally, desert ecotourism is another alternative livelihood releasing pressure from the meager desert dryland resources, and is likely to be economically and environmentally sustainable, based on the pristine wilderness desert areas, their cultural and aesthetic values.

Surely the development path favoring alternative livelihoods cannot completely substitute the improvement of traditional means of exploiting land productivity as measures to achieve sustainability in the Mediterranean drylands. Rather, the appropriate strategy for dryland sustainable development is to apply the two approaches jointly (Adeel and Safriel, 2008), but through a quantitative mix of the two specific to the degree of aridity. Namely, the success of traditional livelihoods based on land productivity promoted with advanced methods will increase with decreasing aridity. Thus, the greater share of traditional methods in that mix is expected in the northern Mediterranean drylands and especially in the dry-subhumid ones. At the same time the success of alternative livelihoods, with a decreasing dependence on land productivity will increase with aridity, and some of these alternative livelihoods will be more successful in hyperarid than in arid desert drylands, namely – in the southern Mediterranean countries (Fig. 14). This is so because both land productivity and its resilience to pressure naturally decrease with aridity (Fig. 6), hence pushing productivity over its natural level requires more efforts and become more risky as aridity increases. Many of the "alternative livelihoods" on the other hand, not only do not depend on land productivity and hence are indifferent to increased aridity, but they benefit from attributes that go together with aridity (e.g., solar radiation and wilderness, supporting alternative energy and tourist industry development, respectively). It is likely that the balance of the two development paths in the mix is to be found at

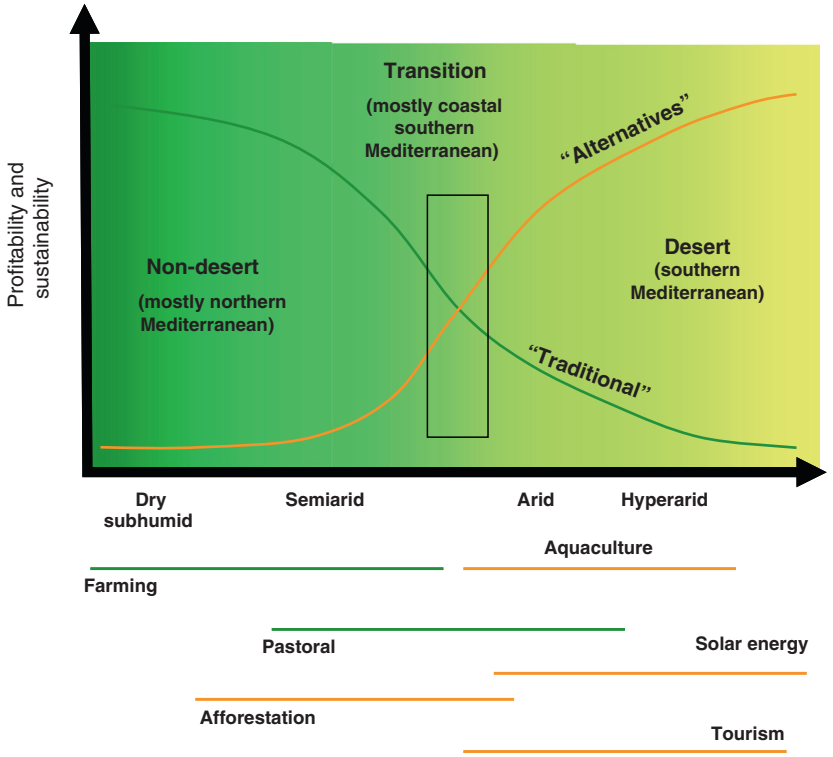


**Fig. 14** The proposed mix for the Mediterranean Basin of traditional and alternative dryland livelihoods, along the aridity gradient. (e.g. the alternative dryland livelihood of aquaculture, that does not impact the land, is advantageous in hyperarid areas where competition with farming on land use is minimal, while afforestation, based on biological productivity but generates income through the carbon market, is advantageous in semiarid areas; farming is best in the least dry dryland, the dry-subhumid one). The transition between desert drylands and non-desert drylands has a potential for high diversity of livelihoods, thus may be the most resilient area. In the Mediterranean Basin it is located mostly in the coastal areas of the southern Mediterranean countries

the transition between the desert and the non-desert drylands, located mainly in the coastal regions of the southern Mediterranean countries (Fig. 14, vertical rectangle).

To conclude, livelihoods associated with the need to sequester carbon (afforestation in the non-desert Mediterranean drylands) and to mitigate climate change (solar energy development in the desert drylands), other livelihoods of advantage in drylands yet not depending on dryland land resources, can be mixed with improvements of traditional dryland livelihoods in the Mediterranean Basin. Quantitatively, this mix is likely to vary between the different Mediterranean dryland types, which would also be expressed a southern Mediterranean mix that is different from the northern Mediterranean one. Hopefully, the southern Mediterranean countries not only would avoid further desertification, but rather than exporting migrants to the northern Mediterranean countries, the latter may benefit both economically and

environmentally from solar energy imported from the formers. Furthermore, the direction of human flow across the Mediterranean would change, from migrants from south to north, to tourist from the European Mediterranean countries to the desert drylands of the southern, African Mediterranean. Altogether it is aspired that the development path described above would promote sustainability of dryland livelihoods, environmental security and subsequent political stability in the whole Mediterranean Basin.

## References

Adeel, Z. and Safriel, U. 2008. Achieving sustainability by introducing alternative livelihoods. *Sustainability Science Journal* 3(1):125–133.

Adeel, Z., Safriel, U., Niemeijer, D., and White, R. 2005. Ecosystems and Human Well-being: Desertification Synthesis. Millennium Ecosystem Assessment, World Resource Institute, Washington, DC.

Alpert, P., Ben-Gal, T., Habarad, A., Benjamini, Y., Yekutiel, D., Colacino, M., Diodato, L., Ramis, C., Homar, V., Romero, R., Michaelides, S., and Manes, A. 2002. The paradoxical increase of Mediterranean extreme daily rainfall in spite of decrease in total values. *Geophysical Research Letters* 29(11):1536.

Aschmann, H. 1973. Distribution and peculiarity of Mediterranean ecosystems. PP. 11–19 in Di Castri, F. and Mooney, H.A. (Eds) Mediterranean Type Ecosystems. Ecological Studies, 1973, 7. Springer-Verlag, Berlin.

Baldwing-Edwards, M. 2004. The changing mosaic of Mediterranean Migrations. Migration Information Source, at http://www.migrationinformation.org/feature/print.cfm?ID=230.

Bellot, J., Maestre, F.T., Chirino, E., Hernández, N., and de Urbina, J.O. 2004. Afforestation with *Pinus halepensis* reduces native shrub performance in a Mediterranean semiarid area. *Acta Oecologica* 25:7–15.

Boix, C., Calvo-Cases, A., Imeson, A., and Lavee, H. 1998. The Ermes Programme. PP. 18–20 in Mariota, P., Thornes, J.B. and Geeson, N (Eds) Atlas of Mediterranean Environments in Europe. The Desertification Context. Wiley, Chichester.

Boserup, E. 1965. The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure. Aldine, Chicago.

Brauch, H.G., Liotta, P.H., Marquina, A., Rogers, P.F., and Selim, M.S. 2003. Security and Environment in the Mediterranean. Conceptualising Security and Environmental Conflicts. Springer, Berlin.

Christensen, J.H. and Hewitson, B. 2007a. Regional climate projection. PP. 849–940, in Climate Change 2007 – The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the IPCC. Cambridge University Press, Cambridge.

Christensen, J.H. and Hewitson, B. 2007b. Regional climate projection. Supplementary material to Ch. 11 of Climate Change 2007. The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the IPCC. http://ipcc-wg1.ucar.edu/wg1/Report/suppl/AR4WG1_Ch11-suppl.html.

Clark, S.C., Puigdefabregas, J., and Woodward, I. 1998. Aspects of the ecology of the shrub-winter annual communities in the Mediterranean Basin. PP. 44–47 in Mariota, P., Thornes, J.B. and Geeson, N (Eds) Atlas of Mediterranean Environments in Europe. The Desertification Context. Wiley, Chicester.

Correia, F.N. 1999. Water resources under the threat of desertification. PP. 215–241 in Balabanis, P., Peter, D., Ghazi, A. and Tsogas, M. (Eds) Mediterranean Desertification. Research Results and Policy Implications. Vol. 1.

Dayan, U. and Koch, J. 1999. Implications of Climate Change on the Coastal Region of Israel. Mediterranean Action Plan, United Nations Environment Programme.

Ezcurra, E. 2006. Natural history and evolution of the world deserts. PP. 1–26 in Ezcurra, E. (Ed.) Global Deserts Outlook. UNEP, Nairobi.

GEF 2005. Proposed memorandum of understanding between the United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa and the Global Environment Facility. GEF/C.25.5, April 29, 2005, GEF Council, June 3–8, 2005. http://www.gefweb.org/interior.aspx?id=16734&terms=Desertification.

Glantz, M.H. and Orlovsky, N.S. 1983. Desertification: A review of the concept. *Desertification Control Bulletin* 9:15–22.

Gleick, P. (Ed) 1993. Water in Crisis – A Guide to the Worlds' Fresh Water Resources. Oxford University Press, Oxford.

Homer-Dixon, T.F. 1994. Environmental scarcities and violent conflict: Evidence from cases. *International Security* 19(1):5–40.

ICARDA 2007. Building Bridges of Confidence through Technical Dialogue. Middle East and North Africa Regional Initiative for Dryland Management. International Center for Agricultural Research in the Dry Areas (ICARDA) Final Report. Published by FAO, available at http://www.fao.org/docrep/010/a1231e/a1231e00.htm.

IPCC 2007. Climate Change 2007. Synthesis Report. Cambridge University Press, Cambridge.

Jeftic, L. 1993. Implications of expected climate change in the Mediterranean region. PP. 278–302 in Graber, M., Cohen, A. and Magaritz, M. (Eds) Regional Implications of Future Climate Change. Proceedings of an International Workshop, Weizmann Institute of Science, Rehovot Israel April 28–May 2, 1991 (The Israeli Academy of Sciences and Humanities and State of Israel, Ministry of the Environment).

Kadomura, H. 1997. Data book of desertification/land degradation. http://www-cger.nies.go.jp/cger-e/db/desert-e.html.

Lash, J. 2007. The wealth of the poor. *Frontiers in Ecology and the Environment* 5:171–172.

Lavee, H., Imeson, A.C., and Sarah, P. 1988. The impact of climate change on geomorphology and desertification along a Mediterranean-arid transect. *Land Degradation and Development* 9:407–422.

Lepers, E. 2003. Synthesis of the Main Areas of Land-cover and Land-use Change. Millennium Ecosystem Assessment, Final Report. http://www.geo.ucl.ac.be/LUCC/lucc.html.

Lindqvist, S. and Tengberg, A. 1993. New evidence of desertification from case studies in Northern Burkina Faso. *Geografiska Annaler*. *Series A*, *Physical Geography* 75(3):127–135.

Lopez-Bermudez, F., Romero-Diaz, A., Cabezas-Calvo, R.F., Rojo-Serrano, L., Martinez-Fernandez, Jose, Martinez-Fernandez, Julia, Boer, M., and Del Barrio, G. 1998. The Guadalentin Basin, Murcia, Spain. PP. 130–142 in Mariota, P., Thornes, J.B. and N. Geeson (Eds) Atlas of Mediterranean Environments in Europe. The Desertification Context. Wiley, Chichester.

MA 2005. Ecosystems and Human Well-Being: Synthesis. Island Press, Washington, DC.

Maestre F. T. and Cortina, J. 2004. Are *Pinus halepensis* plantations useful as a restoration tool in semiarid Mediterranean areas? *Forest Ecology and Management* 198:303–317.

Maestre, F.T., Cortina, J., Bautista, S., and Bellot, J. 2003. Does *Pinus halepensis* facilitate the establishment of shrubs in Mediterranean semi-arid afforestations? *Forest Ecology and Management* 176:147–160.

Matthiew, R.A., Gaulin, T., and McDonald, B. 2003. The elusive quest: Linking environmental change and conflict. *Canadian Journal of Political Science* 36(4):857–878.

Mazzucato, V. and Niemeijer, D. 2002. Population growth and the environment in Africa: Local informal institutions, the missing link. *Economic Geography* 78:171–193.

Meehl, G.A. and Stocker, T.F. 2007. Global Climate Projections. PP. 748–845 in IPCC Fourth Assessment Report, Working Group I report "the Physical Science Basis", Cambridge University Press, Cambridge, England.

Mendizábal, T. and Puigdefábregas, J. 2003. Population and land uses changes: Impacts on desertification in Southern Europe and in the Maghreb. PP. 687–701 in Brauch, H.G., Liotta, P.H., Marquina, A., Rogers, P.F. and El-Sayed Selim, M. (Eds) Security and Environment in the Mediterranean. Springer.

Meyerson, F.A.B., Merino, L., and Durand, J. 2007. Migration and environment in the context of globalization. *Frontiers in Ecology and the Environment* 5:182–190.

Middleton, N. and Thomas, D. 1997. World Atlas of Desertification. Arnold, London.

Millán, M. M., Estrela, M. J., Sanz, M.J., Mantilla, E., Martín, M., Pastor, F., Salvador, R., Vallejo, R., Alonso, L., Gangoiti, G., Ilardia, J.L., Navazo, M., Albizuri, A., Artíñano, B., Ciccioli, P., Kallos, G., Carvalho, R. A., Andrés, D., Hoff, A., Werhahn, J., Seufert, G., and Versino, B. 2005. Climatic feedbacks and desertification: The Mediterranean model. *Journal of Climate* 18(5):681–701.

Mortimore, M.J. and Adams, W.M. 2001. Farmer adaptation, change and crisis in the Sahel. *Global Environmental Change* 11:49–57.

Naveh, Z. 1990. Ancient man's impact on Mediterranean landscapes in Israel – ecological and evolutionary perspectives. PP. 43–50 in Bottema, S., Entjes-Nieborg, G. and Van Zeist,W. (Eds) Man's Role in the shaping of the East Mediterranean Landscape. AA Balkema, Rotterdam.

Naveh, Z. 1991. The role of fire in Mediterranean vegetation. *Botanika Chronica* 10:385–405.

OASIS 2006. Poverty and desertification. http://www.oasisglobal.net/index.html.

Osborne, C.P., Mitchell, P.L., Sheehy, J.E., and Woodward, F.I. 2000. Modelling the recent historical impacts of atmospheric $CO_2$ and climate change on Mediterranean vegetation. *Global Change Biology* 6(4):445–458.

Puigdefabregas, J. 1995. Desertification: Stress beyond resilience, exploring the unifying process structure. *Ambio* 24:311–313.

Puigdefábregas,[a] J. and Mendizabal, T. 1998. Perspectives on desertification: Western Mediterranean. *Journal of Arid Environments* 39(2):209–224.

Radogou, K. 1999. Rehabilitation of ecosystems in the Mediterranean vegetation zone in Greece under natural methods. Pp 517–526 in Balabanis, P., Peter, D., Ghazi, A. and Tsogas, M. (Eds) Mediterranean Desertification, Vol. II.

Reij, C., Scnoones, I., and Toulmin, C. 1996. Sustaining the Soil: Indigenous Soil and Water Conservation in Africa, Earthscan, London.

Reynolds, J.F., Stafford Smith, D.M., Lambin, E.F., Turner II, B.L., Mortimore, M., Batterbury, S.P.J., Downing, T.E., Dowlatabadi, H., Fernández, R.J., Herrick, J.E., Huber-Sannwald, E., and Jiang, H. 2007. *Science* 316:847–851.

Rubio, J.L. and Recatala, L. 2006. The relevance and consequences of Mediterranean desertification including security aspects. PP. 133–165 in Kepner, W.G., Rubio, J.L., Mouat, D.A. and Pedrazzini, F. (Eds) Desertification in the Mediterranean Region: A Security Issue. Valencia NATO Workshop, Springer.

Safriel, U.N. 2006. Dryland development, desertification and security in the Mediterranean. PP. 227–250 in Kepner, W.G., Rubio, J.L., Mouat, D.A. and Pedrazzini, F. (Eds) Desertification in the Mediterranean Region. A Security Issue. NATO Security through Science Series, Volume 3, Springer, Germany.

Safriel, U.N. 2007. The Assessment of global trends in land degradation. PP. 1–38 in Sivakumar, M.V.K. and Ndiaugui, N. (Eds) Climate and Land Degradation, Springer, Berlin.

Safriel, U. and Adeel, Z. 2005. Dryland systems. PP. 623–662 in Hassan, R., Scholes, R. and Ash, N. (Eds) Ecosystems and Human Well-Being: Current State and Trends. Island Press, Washington, DC.

Safriel, U. and Adeel, Z. 2008. Development Paths of Drylands – Is Sustainability Achievable? *Sustainability Science Journal* 3(1):117–123.

Shachanovitch, Y., Berliner, P.R., and Bar, P. 2008. Rainfall interception and spatial distribution of through fall in a pine forest planted in an arid zone. *Journal of Hydrology* 349:168–177.

Thornes, J.B. 1988. Competitive vegetation – erosion model for Mediterranean countries. PP. 255–282 in Morgan, R.P.C. and Rickson, R.J. (Eds) Agriculture, Erosion Assessment and Modeling. Comm. Eur. Com. Report EUR 10860 EN, Office for Official Publications. Luxembourg.

Thornes, J.B. 1999a. Mediterranean Desertification: The issues. PP. 9–15 in Balabanis, P., Peter, D., Ghazi, A. and Tsogas, M. (Eds) Mediterranean Desertification. Research results and policy implications. Vol. 1.

Thornes, J.B. 1999b. Results and prospects. PP. 162–163 in Balabanis, P., Peter, D., Ghazi, A. and Tsogas, M. (Eds) Mediterranean Desertification. Research results and policy implications. Vol. 1.

Thornes, J.B. 1999c, Results and prospects. PP. 162–163 in Balabanis, P., Peter, D., Ghazi, A. and Tsogas, M. (Eds) Mediterranean Desertification. Research results and policy implications. Vol. 1.

Tiffen, M. and Bunch, R. 2002. Can a more agroecological agriculture feed a growing world population? PP. 71–91 in Uphoff, N. (Ed) Agroecological Innovations. Earthscan, London.

Tiffen, M., Mortimore, M., and Gichuki, F. 1994. More People, Less Erosion: Environmental Recovery in Kenya. Wiley, London.

UN 2004. Managing Fragile Ecosystems: Combating Desertification and Drought. In: http://www.un.org/esa/sustdev/documents/agenda21/english/agenda21chapter12.htm.

UNCCD 2007a. United Nations Convention to Combat Desertification. Article 1. Use of terms. http://www.unccd.int/convention/text/convention.php?annexNo=−1

UNCCD 2007b. Annex 5. http://www.unccd.int/convention/text/convention.php?annexNo=5.

UNCCD 2007c. Food crisis and land crisis? Options for the international community to move forwards in an integrated manner. http://www.unccd.int/convention/text/convention.php?annexNo=5.

UNCCD 2007d. Draft ten-year strategic plan and framework to enhance the implementation of the Convention (2008–2018). ICCD/COP(8)/10/Add.2 http://www.unccd.int/php/document.php?ref=ICCD/COP(8)/10/Add.2.

UNCCD 2007e. The Convention. http://www.unccd.int/convention/menu.php.

Verstraete, M.M. 1986. Defining desertification: A review. *Climatic Change* 9:5–8.

Warren, A. 2006. Challenges and opportunities – change, development, and conservation. PP. 89–109 in Ezcurra, E. (Ed) Global Deserts Outlook. UNEP, Nairobi.

Wessels, K.J., Prince, S.D., Frost, P.E., and van Zyl, D. 2004. Assessing the effects of human-induced land degradation in the former homelands of northern South Africa with a 1 km AVHRR NDVI time-series. *Remote Sensing of Environment* 91:47–67.

Yassoglou, N. 1999. Land, desertification vulnerability and management in Mediterranean landscapes. PP. 87–113 in Balabanis, P., Peter, D., Ghazi, A. and Tsogas, M. (Eds) Mediterranean Desertification. Research results and policy implications. Vol. 1.

# Desertification and Water Scarcity as a Security Challenge in the Mediterranean

**José L. Rubio**

## Introduction

There is a new perception of a global dimension: environmental security. The protection of our fixed and shared environment is gradually coming to people's attention as an obligatory requirement for equitable development, in order to prevent disasters related to environmental security and to avoid conflicts. The Euro-Mediterranean Region is also immersed in this general trend partly as a consequence of more frequent severe environmental events, such as forest fires, floods and landslides, droughts, torrential rains, heat waves and water scarcity. The Southern and Eastern shores of the Mediterranean undergo even more harsh environmental impacts affecting the stability of the land, its capacity to produce food and the lack of water resources. These environmental conditions are the origin of recurrent famines, social marginalization, conflicts and forced population displacement.

However the perspective today is more regional than global. We are in a historical moment by changing the perception of security in parallel with the global consciousness. The traditional security dimension (military, societal, economic, political . . . ) has evolved in an intricate and complex process including aspects of human security and environmental security. The latest dimension is an emerging issue that is gaining importance and consideration due to their implications for the well being of people and for its latent potential as a source of conflict. Besides that, it has distinctive implications:

- It has multisectoral dimension. The consequences of severe environmental degradation affects not only the environmental functioning of the biosphere but the impacts are translated to economic, health, cultural and political sectors. Desertification, poverty and migrations are good examples of such a cross cutting issues.

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- It has global dimension. We shared a common environment. Some environmental problems develop in specific parts of the planet but the causes and consequences could affect the all world. Changes in the chemical composition of the atmosphere affect the all climate conditions regardless of the origin of the emissions. Moreover, climatic alterations affect the functioning of the rest of the ecosystem components: land and soil, agrarian production, surface water and soil water, landscape, fauna and microbial populations.
- The actual status of environmental resources, the demographic trends and the increasing pressures on the environment foresee worrying scenarios and an aggravating tendency.
- It is a global and shared responsibility demanding responses in the social, political, technological and scientific sectors.

The Mediterranean is one of the world "environmental hot spot" identified as vulnerable area to climate change and land–water resources deterioration. It has well known climate conditions that have influenced and shaped the long historic use by man. The climate has modelled the rich cultural heritage, the way of life and also the patterns of land use and the landscape. The region shows a common biophysical unity, yet with very different socio-economic and cultural aspects. It is unanimously accepted that the Mediterranean region is not only similar but also diverse, making it very difficult to define. The Mediterranean basin is vast and diffuse. This varies between the limits of olive tree growth, in the most limiting consideration, and the widest limits which includes even Portugal, Bulgaria, the Black Sea, the Red Sea and the Middle East. Its environment is susceptible to environmental impacts due to water stress, topography and difficult climate conditions for biomass development. On the other hand, it is very rich in biodiversity, partly as a consequence of the need for nature to use a wide variety of adaptation strategies to cope with harsh environmental conditions.

It is the meeting point for three continents, the place of origin of some of the most important civilizations and religions of the world (Judaism, Christianity and Islamism), and has exerted tremendous cultural, scientific and technological influence. Economically, it is loosing influence in comparison to other world regions of economic development (Guillaume and Comeau, 2005).

Today and after the terrorism attack of 11 September 2001 in USA, the Mediterranean is directly and indirectly in the center of the security debate. In the internal dimension of security, environmental implications play an important role owing to the interactions of population growth (southern–eastern shores), desertification, water scarcity in quantity and quality, climate change, food production, urbanisation, land use mismanagement and migrations. Indirectly this is because some aspects of the more global dimension of security, like the present civilization–religious conflict, originate in the eastern part of the Mediterranean.

In this paper, together with some conceptual and historic perspectives on security, we will consider environmental aspects related to land surface use and processes and water cycle interactions together with their climatic implications in the context of the loss of ecological and productive functions of the soil.

## Conceptual Perspective

Security is of utmost importance for man and gives him a feeling of protection against harm, danger, fear or anxiety. The human pursuit of security is a prerequisite and a strong motivation for survival. It is basic and consubstantial for man. From the initial aspect of physical security, the term has evolved during human and social evolution to a pleiad of very different scopes including the recent consideration to environmental aspects. Brauch (2003) offers a clear and concise review of the evolution of the concepts of security. His review includes references to traditional intellectual schools (Hobbesian–Machiavellian, Kantian and Grotian), theories on war, peace, conflict; critical security studies, constructivist and deconstructivist approaches, liberalism and postmodernism. He also refers to others concepts as common security, mutual security, co-operative security and security partnership.

From the initial individual physical perception of security to the many social approaches to conceptualise security, there has been a complex and intricate evolution. The literature is rich in many academic studies dealing with the concept of security and its evolution. Muller (2002) discussed some of the very different understandings of security considered today. Part of the problem of the many existing approaches and some lack of consensus is that the term security is vague and difficult to define. Other difficulties are the contextual nature of some security threats and also the subjectivities associated to the perception of security.

Traditionally the concept of security was visualized in terms of security for the first City-States and later of the Nations with the perspective of defence against military campaigns. In the Roman times, the concept of Pax Romana includes the aspect of security as a key argument. Curiously and considering the intrinsic personal perception of security, only after the middle of lst century was the concept extended to cover individual security, social security and others aspects (Ullmann, 1982).

In the last decades of past century institutions like the UNESCO and the FAO have played important roles in changing the scenario. Also, at the academic level the term expanded to include environmental aspects (Buzan, 1998). The Brundtland Report on Sustainable Development of 1987 included an early chapter on environmental security. After that, conceptual and perception evolution security risks, other than military threats posed by others states, have been included on the agenda, such as environmental degradation, socio-demographic challenges or the spread of infectious diseases. Also the UNDP in its Human Development Report (1994) introduced the concept of security for people in terms of protection from poverty, disease, hunger and environmental hazards. The Canadian government defines human security as a freedom from pervasive threats to people's rights, safety and lives.

In some ways, this new vision of human security is a return to the early times of humankind in which security was mainly a physical and individual need. In 1996 the FAO introduced the concept of food security as "the access for all people at all times to enough food for an active, healthy life" (FAO, 1996).

Today there is a growing acceptance of the linkages between environmental disruptions and conflicts. This new issue on the arena requires new appraisals and

new responses far from of the traditional military approaches to conflicts. Meanwhile, environmental threats occur at a local or a regional scale, the implications and consequences of which could have a transboundary dimension or could even be considered as an international problem. This dimension calls for the building up of new cooperation schemes and for approaches towards global equity as a basic appraisal to cope with environmental security.

## Security in the Mediterranean

Throughout history, the Mediterranean has been the crossroads for three continents and the place of the flourishment of many civilizations that have given the world important cultural, scientific and socio-economic developments for centuries. It is also a region with long records of conflicts and wars with an intriguing and intense list of historic security issues.

Wars in early Greece, Roman expansion and conquests, the Arab world spreading out, the Turkish Empire and its confrontations with the Christian empires, early European nations fighting for the Mediterranean land and sea, religious wars and World Wars, all offer a historical perspective of a quasi-permanent conflict. More recently, the problems of France and Spain with the Magreb countries after the colonial times, the rivalry between Turkey and Greece, and the permanent confrontation between Israel and the Arab world, demonstrate the lasting presence of conflict in the region. There are also historical records of trouble with regard to environmental problems. There was early river, soil and air pollution due to mining and metallurgic operations in different areas around the basin, with coin making that caused air pollution because of the large amounts of metals used, mainly copper and lead. Some of the more important cities had early pollution problems. Maimonides (1135–1204), philosopher and physician from Cordoba, Spain, complains sadly about this early urban air pollution in cities in comparison to the rural world. The copper mines from Rio Tinto (Huelva, Spain) have been the source of vast pollution problems for centuries. Similar problems evolved from the glassmaking industry in Venice. Recently Athens and Cairo have been having huge problems of overgrowth and pollution.

Problems related to scarcity or to quality of water are also a permanent historic feature. Istanbul for example has been always a city with water supply problems. There are records even from the Byzantine period of enormous efforts with infrastructures (including pipes below the Bosphorous Strait) to bring water to the city and also accounts about problems of pollution and sanitarian levels. This situation could include similar problems of water supply to urban developments through the basin and to cities like Rome or Barcelona.

But going back to security in its traditional perception, the more recent important episodes that caught public and government attention could be situated in early 1970s. At that time the oil prices crisis and terrorism activity due to the Palestinian–Israel conflict were the two most significant issues. The Munich terrorist attack during the Olympic games of 1972 was the decisive moment in the public debate

and in the initiation of decisions and initiatives to address security issue. After this decade initiatives like the Global Mediterranean Policy were adopted.

From 1990s until now the most important security concerns, in its wide acceptation, are related first to the issue of terrorism but now include the fundamentalisms dimension and implications. The second issue is related to the growing dimension of the migration phenomenon that is gaining visibility with impacts in both areas of origin and of reception. The third and also a growing security concern is the environmental disruption of natural resources and the implications on social and economic activities and the well being of persons. Famine, social instability, forced migrations and conflicts are some of the consequences of environmental disruption.

## Desertification

The desertification risk is an environmental problem of worldwide scope that affects the five continents. The latest consequences represent the dismantling of all the biospheric potential of the affected zone and its conversion into a barren and unproductive territory. The process begins with the deterioration of the soil due to different degradation processes such as water and wind erosion, loss of organic matter, destruction of the structure, compaction, sealing or salinization–sodification. The effects of soil loss or the loss of its productive and ecological functions is transferred to the other components of the terrestrial ecosystem (water resources, plant cover, soil fauna and microorganisms) in a self-feed spiral that in its last instances gives rise to a sterile and desolate landscape with irreversibility connotations. This, fortunately, only takes place when the situation is extreme. In the affected zones one can find all kinds of situations, from zones very slightly affected to zones that show evident symptoms of deep degradation. The Mediterranean is considered as one of the areas highly vulnerable to desertification (Rubio and Recatala, 2006). In this book the chapter from Uriel Safriel offers an overview of the status of desertification in the Mediterranean basin.

Desertification risk affects a multitude of different processes with different scales of performance and different intensities. Their sectorial consequences also are varied and diverse, affecting not only to the environmental aspects but also very diverse productive sectors. This complexity and multi sectoriality is one of the causes by which the desertification problems resist an easy perception from society and also they make the adoption of effective control measures difficult.

The United Nations Convention to Combat Desertification (UNCCD, 1994), Article 1, defined desertification as land degradation in arid, semi-arid and dry-sub humid areas resulting from various factors, including climatic variations and human activities. Arid, semi-arid and dry-sub humid areas are defined as areas other than polar and sub-polar regions, in which the ratio of annual precipitation to potential evapotranspiration (P/ETo) falls within the range 0.005–0.65. That means areas (drylands) with large water deficits because potential evapotranspiration (ETo) is much greater than precipitation (P). Land is the terrestrial bio-productive system

that comprises soil, vegetation, other biota, and the ecological and hydrological processes. Land degradation means loss of the biological and economic productivity of rainfed or irrigated cropland, or range pasture, forests and woodlands resulting from various factors, including climatic variations and human activities such as unsustainable land uses. Degradation processes includes deterioration of soil properties, soil and water erosion, long term loss of natural vegetation, reduction or loss of the biological productivity, salinisation and sodification. Therefore, in the broadest terms, desertification includes the degradation of soil, water, vegetation and other resources.

The climatic induced situations of a structural negative balance of water in the drylands establish the context of the biological functioning of the land, the biomass productivity and the soil properties and capacity of use. It also establishes the status of vulnerability as a result of natural impacts (like drought) or human pressures and because of the structural difficulties of self restoration. In the initial phases of desertification process they occur unnoticed because no apparent change is observed in soil functions performance. However there is occurring a silent and hidden set of processes that gradually diminishes the biological quality of the soil and its potential to produce biomass and other ecological functions like water cycle regulation and storage. Soil has its own capacity to recover after impacts by its resilience capability but this self restoration capacity is not very strong in the soils of the drylands.

Under continuous impacts as inadequate agricultural practices that are maintained during years, under forest fires impacts or under the use of salty water for irrigation, the soil initiate an accelerating and progressive loss of biological potential and productive capacity. If the mismanagement continues or the arid climatic conditions are maintained because of a drought period, the soil loses its capacity of resilience or the biological flexibility of the land to adapt to a harsh conditions or pressures. Under these situations the return to the initial conditions becomes more problematic. In the soil capacity to recover, the levels of organic matter and a well developed soil structure play an important role. Nevertheless, this oscillation (impact-recovery), that can stay within certain conditions of balance, at some certain range of variations in the level of impacts or environmental changes, can exceed a certain level of threshold and can trigger a compulsive change through which serious degradation process take place and progressively with less possibilities of return to the initial conditions. That is, severe desertification of an area will proceed if certain land components degrade beyond specific thresholds, beyond which further could became irreversible (Kirby and Kosmas, 1999; Rubio, 2007). It is the typical situation of nonlinear answer of some processes that behave with this pattern after serious or repeated impacts. This situation of irreversibility is already frequent in numerous landscapes of the Mediterranean.

The advanced states of desertification imply a double rupture. On the one hand a disruption in the capacity of the land to produce goods and services and on the other hand the rupture and collapse of the regulations and ecological functions of the soil. These are the extreme conditions of desertification in which all the biospheric potential of the zone is affected. These conditions appear, for example in forest zones with rocky outcrops generalized by extreme erosion and drags of the soil,

in conditions of irrigated land with high salinisation or sodification or in extreme conditions of compaction or contamination. Under these extreme situations agrarian productivity could decrease to limits of food shortage and the instability of the affected–degraded soil could dramatically increase the economic consequences of land slides and flooding and enlarge the loss of human lives and properties.

According to the UNCCD–Annex IV, the main factors that make the Mediterranean susceptible to the desertification risk are the following:

- Semi-arid climatic conditions affecting large areas, seasonal droughts, very high rainfall variability and sudden and high intensity rainfall
- Poor and highly erodible soils, prone to develop surface crust
- Uneven relief, with steep slopes and very diversified landscapes
- Extensive forest coverage losses due to frequent forest fires
- Crisis conditions in traditional agriculture with associated land abandonment and deterioration of soil and water conservation structures
- Unsustainable exploitation of water resources leading to serious environmental damage, including chemical pollution, salinization and exhaustion of aquifers
- Concentration of economic activity in coastal areas as a result of urban growth, industrial activities, tourism and irrigated agriculture

These circumstances affect different aspects of soil properties and soil dynamic but specially affect one of the crucial properties of the soil: its structure. The kind, the degree of development and the quality of the soil's structure regulate important functions. Some of them are the regulation of the humidity reserves, the biological activity, the gas exchanges with the atmosphere, the dynamics of nutrients or the resistance to the erosion processes. The structure of the soil is the result of the aggregation of its mineral components (particles of clay, silt and sands) and the organic components. The degradation of the structure of the soil can be increased by the climatic aridification trend, with numerous and important consequences. The basic process that could be affected is the alteration in the dynamics of the decomposition of the plant residues. It could become unbalanced by increasing the processes of mineralization, harming the complex and slow biochemical processes of humification that give rise to the formation of humus. Humus is an essential compound for the stability and functions of the soil and, to a great extent, responsible for the aggregate formation. The decrease of the proportion of humus in the soil and its consequences in the degradation of the structure affects the capacity of the soil to manage and to maintain the humidity reserves. Also it affects to the dynamics of the nutrients and therefore the chemical fertility of the soil. The degradation of the structure also affects the physical properties of the soil making them worse and diminishing for example the intrinsic capacity of the soil to support erosive processes.

Another important function of the soil that can be diminished is its capacity to buffer extreme climatic episodes. Among them it could include the impacts of droughts or the torrential rain effects. A degraded soil is intrinsically less stable and more easily disrupted and mobilised. Its capacity of infiltration also could be affected with an increase in the relative values of run-off and its sediment load. Under these circumstances the destructive effects of the landslides, avalanches, etc.,

floods are increased. The effects give rise to damages in the agrarian production, impacts in inhabited areas and infrastructures, the silting of dams and marshes and damages to communication infrastructures. Logically, also they increase the economic demands to the administration and the insurance concerning damage caused.

In the last two decades in the European Union and in the Mediterranean, the incidence of some extreme climate situations has increased (e.g. torrential rains and floods). The weakening of the buffering capacity of the soil can, more likely, increase the consequences of these extreme phenomena in the immediate future. This situation is aggravated by the litoralisation effects in many coastal areas of the Mediterranean basin. The conjunction of close mountainous ranges near to the sea, the sealing effect of urbanization and the barrier effect of communication infrastructures, greatly increase the destructive energy of torrential rain in the costal zones by increasing the soil erosion intensity, soil dismantling and flooding and sedimentation consequences. Coastal areas of Spain, Italy and Greece increasingly suffer those severe impacts on economics properties and human lives.

Of smaller extension, but qualitatively very important, it is also necessary to consider the possibility greater damage to buildings, due to the phenomena of expansible clay retraction affecting to the conditions of lying of foundations for buildings and civil works.

## Desertification and Climate Change

Soils are a living system and because of their biological component they are very sensitive to temperatures variations and water availability. This is one of the reasons why Mediterranean soils are vulnerable to climate change and the aridification trend in the drylands. Moreover, climate change and desertification are linked in a series of feedback mechanisms that affect both processes (Rubio, 2007).

The predictions of climate change tendencies identifies the Mediterranean region as one of the most sensitive and susceptible zones. Within the multiple existing predictions, there seems to be a certain consensus according to which a temperature increase between 2°C and 6.3°C is expected, a considerable decrease of rainfall, an increase in the frequency of extreme phenomena, an increase of evapotranspiration, a decrease if the humidity reserve of the soil and a greater incidence of droughts. This tendency fundamentally implies a general tendency of aridification. In the soil, this tendency entails an increase in the mineralization and a loss of organic components of the soil. It is considered that the loss of humus in the soil, which has increased from the Industrial Revolution, is, at the moment, about 760 million tons per year. The tendency is an increase due to the degradation of the soil and to the effects of the global warming. Under this perspective, the soil conditions in the dryest zones of the planet, including the Mediterranean, are of special concern.

In the opposite sense, soil degradation impacts on important parameters of climatic regulation and on important biogeochemical cycles that affect the atmospheric chemical composition. Among others it is important to emphasise: changes in the albedo characteristics, radiative forcing, soil humidity, surface roughness, evapotranspiration, emission and retention of gases with greenhouse effect (carbon dioxide, methane, nitrous oxides), changes in the condensation surfaces and the emission of aerosols and dust particles. Probably one of the most serious consequences of the tendency of global warming is the impact in the processes of land degradation–desertification of the drylands of the planet and, also, the feedback of desertification processes with an increasing tendency of climate change (Rubio, 2007). The aggravating trend could develop a self-feeded spiral in soil and water degradation problems in the Mediterranean, that will not only affect the stability and functioning of the natural environment, but also could involve environmental security problems (forced migrations, water shortage, food security, diseases, heat waves, forest fires). This could also involve important damage and socio-economic consequences during extreme climate events (droughts, torrential rains, floods and landslides). These interactions between desertification and climate change are the object of increasing attention. At the same time, scientific knowledge is required for the impact of different climate factors on different processes from degradation of the soil and its capacity to regulate climate factors to climate regulating systems.

Within the many interactions between soil degradation and climatic change, the albedo of the surface of the soil and the radiation balance to the atmosphere, are of particular interest. The albedo is the relation, expressed in percentage, of the radiation that a reflected surface in relation to the radiation that affects the same one. A surface without reflected light would have an albedo of value zero whereas a surface that reflected all the incident radiation would have an albedo of the 100%. The average Earth albedo is of around 30% but based on the characteristics of the terrestrial surfaces their values vary widely. Snow has an albedo around 90% and the oceans oscillate between 5% and 10%. The albedo of the soil also varies widely based on its own characteristics (contained of organic matter, color) and of its plant cover or use. Soil lacking plant cover, a barren or semi-arid Mediterranean zone, can have an albedo between 15% and 25% (elevated reflection) whereas a dense forest or the surface of a humid forest soil can have an albedo with values around 8%. The deserts show the highest albedos on earth not covered by ice or snow.

These different albedos, or the changes in their values due to the use of the soil or degradation processes, have influenced the local climate conditions by affecting rainfall, convection and precipitation development processes (Rubio, 2007). Nevertheless the quantification of their effects on the tendency of global warming has not yet been established and, at the moment, is object of numerous investigations.

With regard to the albedo characteristics in the degraded or desertificated zones, there is a change of color towards clear tones with a decrease in the plant cover, humus and litter. It generally shows a loss of organic matter from the soil. These degraded zones can be marly, off-white and grayish in color or even with surface saline florescences. The clear tones imply increase of albedo, that is to say, an increase in the reflection of the radiations that affect the surface of the soil.

According to the hypothesis of Otterman (1974) and Charney (1975), this change of albedo has repercussions in the precipitation regime at local levels that can affect the zone. According to this hypothesis, the increase of albedo induces a net reduction in the radiation of a short wave. It tends to induce a cooling of the soil surface that increases the subsidence process. It also gives rise to the reduction in the convection and the formation of clouds. As a result of this reduction in the atmospheric instability, the precipitation possibilities are reduced in the area.

The opposite happens with the increase of albedo, that is to say, with the decrease of the reflection. This circumstance corresponds to darker colors on the surface of the soil, such as dense plant cover, abundant presence humus or the existence of a rich topsoil and, as a result, black or grayish-brown in color. Evidently, these characteristics do not correspond to desertified zones but quite the opposite. In these situations of little albedo, a greater heating of the soil surface takes place that tends to increase the convection processes. With this increase in the instability, the possibility of precipitation in the area increases.

Therefore, according to the Otterman–Charney hypothesis desertified areas are more likely to increase their risks of desertification owing to those circumstances that reduce the possibilities of vital precipitations that would alleviate the degradation spiral. On the contrary, the stable, fertile zones and with good plant cover has greater possibilities of increasing their water storage levels and the possibilities to resist to the desertification.

Other effects related to desertification are those that affect the radiative forcing. The soil surface receives a continuous flow of solar energy of 341 $W/m^2$. Part of this energy is absorbed by the land surface and by the atmosphere; another part is reflected back into the space. Human activities (emissions, changes in soil use, degradation) can alter this balance causing disturbances or forcing. The radiative forcing is the difference between the energy of the incoming radiation and the projection in a certain climate system. When a positive radiative forcing exists, that is to say, more incoming energy than salient, the system tends to warm up. If the forcing is negative, the tendency is towards cooling. The concept of radiative forcing has been used by the IPCC in the context of an evaluation that allows detection changes in the balance of radiations of the climate Earth system, caused by disturbances (forcing) external to the system (for example human activities). In this sense, the values of global averages between 1750 and 2005, of greenhouse gases, tropospheric ozone, the decrease of albedo and the stratospheric water steam, have a positive forcing that supposedly contributes to the heating. On the contrary, the aerosols (on all sulfides) or the decrease of albedo would have a cooling effect. The radiative forcing is one of the many parameters of interaction between processes of desertification and systems of climate regulation. Changes in soil use, land degradation, forest fires and urbanization pressures in the Mediterranean are processes contributing to radiative forcing.

## Forest Fires

Nowadays wild fires are one of the most important factors increasing the risk of desertification in the Mediterranean. Fire is an ecological component of Mediterranean ecosystems contributing to the modelling of the landscape and forcing adaptive responses of the vegetation. Neolithic man used fires as a tool for different purposes; burning forest land for farming, for hunting activities, straw burning and military campaigns, are some examples. However, the number of wild fires was kept at a relatively low level until the 70s this past century. After that, the number of forest fires and burned areas in southern Europe increased dramatically. Due to the economic effort and the building of infrastructures, the extension of the area affected shows a downward trend, however the number of fires is still increasing. It is probable that the climate warming trend and its aridification implications around the Mediterranean will increase the menace of wild fires. During 2005, the total area burned in five EU Members States (France, Greece, Italy, Portugal and Spain) was 589.559 ha. In the same year the number of fires that occurred were 73.325. Both figures are well above the average for the last 26 years (European Communities, 2006). Human losses during period 2005–2007 were 95 casualties.

Historical records of the Mediterranean show a relationship between drought and the number of fires. The tremendous increase of forest fires in Portugal during 2003 and 2005 coincides with a long period of severe drought. This could be a premonition of worrying perspectives related to the implications of the climate aridification trend and the likely increase of forest fires.

## Water Scarcity

In the report of the Club of Rome on Limits to Growth considering the growth of the population, the economic and technological development, the impact of natural resources, the ecological track, etc., they found these limits (including the hydrological and soil aspects) could be reached around year 2015. Nevertheless, according to these authors in the second publication on the subject (Beyond the Limits to Growth, Meadows et al., 1992), already in the 1990s, the lifting capacity of the planet had been surpassed, with regard to sustainability criteria. Recently, they published a third evaluation (Limits to Growth, 30 years later, Meadows et al., 2004) which summarizes the complex and controversial debate on the limits to growth and to contribute, among other many aspects, interesting considerations and perspectives on the problem of water and soil resources.

A real problem of water shortage exists which, at the moment affects about 2 billion people, with serious health problems. It is thought that in 2003, 25.000 people died everyday from malnutrition and about 6.000 children (under 5 years of age) died from water-related diseases. In the developing countries, 80% of the diseases are water-related. The situation tends to worsen because of four basic reasons: unstoppable increase of the demand and use of water, conditions of salubriousness

and sanitarian, climatic change and aridification in dry zones of the planet and, the loss of the soil to act as regulator of the hydrologic cycle.

Throughout the 20th century the world population has tripled and water consumption has seen a sixfold increase. The three sectors with greater consumption are agriculture, industry and the urban-domestic sector. Its demand has strongly increased since 1950. Agriculture uses more fresh water than anything else, accounting for the 65% of the global consumption. Nevertheless that with the application of saving measures and more efficient technologies, agriculture could reduce its consumption between 10% and 50%. Industry, the power sector, urban and domestic uses, could also contribute a substantial percentage of saving.

The urban use of the water raises two worrisome perspectives. One is the global tendency to concentrate the population in urban areas, like con-urbanization trend in the coastal zones of Mediterranean Europe, and the other is the population increase of huge cities located in semi-arid zones like Cairo or Istanbul. In these cases and the intrinsic water shortage, we can add the problems of pollution, salinisation, cleaning and related diseases that can lead to healthcare problems that could affect millions of people.

In 2003 United Nations Water for All published an important study about the situation of the water resources in the planet, entitled "Water for the Life". Later a new edition was published about this type of global evaluation of the water situation in the world entitled, "Water, a shared necessity". Both are the result of an ambitious program of periodic analyses starting in 2000, with 24 agencies from the UN system concerned about water resources. These studies give a complete analysis of numerous aspects, for example the evaluation of the situation of the ground water extractions and the perspective of sustainability and other resource distribution aspects of the resource in the different continents. Nevertheless, perhaps the most interesting aspects are those related to the analysis of the implications concerning life conditions, economic development and health aspects. UN documents use a moderate and somewhat complicated wording, with circumlocutions in order to avoid susceptibilities in the complex frame of the international relations. Nevertheless they are documents that contribute data and predictions stressing the need for serious consideration and reflection. In this sense, United Nations contemplates two situations. In the pessimistic scene, it believes that 7.000 million people, in 60 countries, will have a water shortage around 2050. The optimistic scene is not flattering. It believes that 2.000 million people, in 48 countries, will have a water shortage in the middle of 21st century.

In the context of the Objectives of Development of Millennium (2015) they includes items with special implication to water perspectives. Between them we emphasize the following ones: Objective 1, to eradicate extreme poverty and hunger; Objective 4, to reduce child mortality; Objective 5, to improve maternal health; Objective 6, to fight malaria and other diseases; Objective 7, to guarantee environmental sustainability; Objective 8, to promote a world-wide agreement for development.

The UN 2006 water report (www.unesco.org/water/wwap) gives a holistic evaluation including water governance, access to the knowledge and specific challenges

about water management and the link to economic development and well-being of mankind. The report includes hundreds of maps, tables, numbers, indicators and case studies. It provides evaluations of the access of the population to sources of potable water and sanitary conditions, in which a dramatic situation in the southern hemispheric, particularly in Africa (including North Africa) is analysed. The estimation of the population without access to suitable conditions of cleaning of the water shows a timid tendency to improve throughout the 21st century. Also the situation of the zones of irrigated land is approached showings a tendency to the containment. This it is an important subject by the massive water consumption that originates the agricultural activities and by its implications in the necessity of food production. The irrigation along with the Green Revolution allowed providing with foods the humanity in their unstoppable demographic increase and also they allowed the improvement of the conditions of life and appreciable economic benefits to million agriculturists. At the moment the perspective is of appreciable non-increase of the irrigated surface but next to it the necessity to improve the productivity by hectare of culture to produce necessary foods to a world-wide population that considers it grows to an exponential rate.

Nevertheless we considered that this increase of agricultural productivity has to take control with criteria of sustainability and expositions environmentally less aggressive than some agricultural practices of the past. Gordon Conway, president of the Foundation Rockefeller proposes one "Double Green Revolution", aiming at these environmental criteria and the possibilities of the biotechnological applications. It is evident that to be able the double objective to maintain the nourishing security and in addition doing it in an environmentally suitable context, they are necessary, among other things: a more environmentalist management of the agrarian operations; better use of fertilizers and soil amendments; better varieties; application of new technologies like the precision agriculture; maintenance of the quality of the soil and its ecological functions and, better use of the water. All it implies, in effect, positions clearly in favor of a new "agricultural revolution".

With regard to the groundwater and aquifer situation, the UN 2006 water report includes results from evaluations that show great overuse, with more than 50% recharge rate, in many Middle Eastern countries as well as in Northern and Southern Africa and some European countries. It also includes an evaluation that was done to study the vulnerability of regions as far as impacts and consequences of droughts and flood risks go. In the last chapter, the report includes a series of conclusions and concrete recommendations to the global community to adopt measures for better water management.

The European Environment Agency (EEA, www.eea.int) of the EU, periodically publishes studies about the situation of different parameters and environmental subjects including water-related ones. An important source of information is their periodic evaluations on environment in Europe; four editions have been published: 1995 (Dobris Report), 1998, 2003 and 2007, providing a general vision of the situation of the European hydric resources and its future perspectives. The 2003 evaluation analyses aspects concerning the extractions and use of the water by sectors, the quality of the water, the levels of pollution. The water situation also

considers other aspects such as industry, energy, fishing and farming. The Thematic Center for Water (ETCW-EEA) also prepares prospective studies, for example different aspects about the situation of water resources in 2030. These evaluations include many diverse aspects: consumption, water availability per river basin and country, drought impacts, the overexploitation of water-bearing, impacts of floods and landslides. Their worrisome predictions are about the Europe of the south, in which it is expected important deficits of water availability that in some cases diminutions of a 25% of the water available indicate (horizon 2030). In these predictions, Spain locates itself in a particularly sensible position.

At European general level the AEA considers that important advances in the ecological quality of the rivers, in the contamination of originating sources of industries and urban areas, in the reduction of phosphorus and organic matter in rivers and lakes, the reduction of spills and effluents have taken place and, in the underground water extraction but indicating the exception in the south of Europe. Among other areas in which it is considered that one has not advanced indicate the water contamination by nitrates, the water stations for the irrigation, salinisation, the production of energy and the tourism and, the accumulation of pesticides in superficial and underground waters.

## The Mediterranean Context

The Mediterranean is a basin historically and biophysically marked by its climatic characteristics and its water availability. Is a zone of climate transition between colder and humid climates in the north, and warmer climates in the south. Climate gives the Mediterranean a very unique personality with numerous cultural and economic connotations. An important source of data about water in the Mediterranean is the UNESCO publications (www.unesco.org) and also their Blue Plan (www.blueplan.org). A publication of very graphical synthesis is the Mediterranean Basin Water Atlas (UNESCO, Blue Plan, 2004) that exposes the situation of the water resources in the river basin of the Mediterranean, the guidelines of present consumption and the levels of operation. The present tendencies of demand in excessive increase on the part of agriculture, the industry and the cities, simply are neither viable nor sustainable. To follow with these tendencies we faced really worrisome scenes. According with Plan Bleu-UNEP (2006) today there are 30 million people in the Mediterranean without access to potable water. It also considers that pressures on water resources will increase significantly, and it is expected that, by year 2025, 63 million people in the Mediterranean will be limited to 500 $m^3$ per capita per year (defined as the shortage threshold).The information and estimations provided are very significant on, for example, the demand of water per capita and by uses, the total water consumption in the Mediterranean, the present indices of operation of hydric resources, the hydric availabilities, etc. In this context Egypt, Italy, Spain,

Israel, Libya and the Palestinian Territories are the countries with higher levels of over-exploitation of their water resources.

Water is a limited and precious resource in the Mediterranean. The main quality issues affecting the availability of water are: organic pollution, pathogens, salinisation, nitrates, heavy metals, acidification, eutrophication and sediment load. The salinisation of water is an important process in Mediterranean environments due to climate conditions and human mismanagement.

Water salinisation is normally linked to soil salinisation. Soil salts are the base of soil fertility and also have important effects in different functional soil processes, for example, the dynamics of soil structure. However, the excess of salts or the unbalance in the ionic composition of soil solution could give rise to serious problems with soil function. The salts which accumulate include chlorides, sulphates, carbonates and bicarbonates of sodium, potassium, magnesium and calcium. Soil salinisation and the related threat of sodification occur mainly in the Mediterranean drylands with preference in three major locations: natural saline coastal zones, inland endorreic saline watershed and zones affected by secondary salinisation owing mainly to inadequate irrigation management. This last process is increasing and it is considered as an important process influencing the increase of desertification.

Droughts are a normal component of Mediterranean climate substantially affecting water availability. Closely related to it is the long historical practice of development of traditional soil and water conservation systems, and besides its regulation functions, constitute a rich cultural patrimony highly visible along the landscape. These traditional systems represent a wise and necessary ecological adaptation and the limitations and whims that one of the basic resources imposes as is the case with water. Terraces, stone walls, captures of water, rain tanks and channels are highly visible in numerous parts of the Mediterranean which constitutes a singular landscape feature. They represent the result of an impressive human effort of hard adaptation to natural conditions of the surroundings, the need to regulate the limited water resources as well as food production. Unfortunately, these traditional systems are in a almost generalised situation of abandonment that would require important performances of maintenance and recovery, if not thinking about a problematic agricultural or economic productivity, but at less as for the maintenance of their important functions of ecological, hydrological and landscaping regulation.

The traditional of conservation of soil and water, developed and applied systems in the past, represent the fight through time to adapt and to obtain productivity of problematic natural surroundings and fundamentally they derive from the shortage of precipitations and climatic variability. It surprises at the moment that capacity of adaptation is apparently lost and that the present droughts are contemplated like an unexpected and surprising phenomena. In that sense we threw to lack a long term planning of adaptation and prevention of the effects of the droughts that in the future will return to us to hit and which lately they are become more and more frequent, probably due to the implications of the tendency of the climatic change.

## Perspectives

The desertification processes includes important climate parameters like main mechanisms of triggering degradation processes. These parameters are related to the temperature, radiation, precipitation, erosivity of rain, evapotranspiration, climatic variability and droughts.

Important mechanisms of feedback between the tendency of climatic warming and the processes of desertification exist, among which the changes of albedo, gas emissions and capture, changes in the balance of the radiations, lost of the capacity to provide cover of vegetation, particulate emission of dust and aerosols and, changes in the evapotranspiration regime, are included. Specially the deterioration of the soil by desertification processes can release enormous amounts of $CO_2$ and alter the balance and the flows of radiations, affecting to the climatic Earth regulation.

An important consideration is that protecting and conserving the soil prevents desertification and in addition, and as a consequence, contributes to the prevention and the mitigation of the climatic change. Both subjects are perhaps, the two environmental priorities that at the moment require the greater effort of international agreement.

The valuation of the socio-economic and security costs derived from the desertification processes, is an important and difficult subject by its multiple sectorial effects and because it includes many aspects of difficult direct economic valuation. It is still non approached in depth and not solved satisfactorily. The costs have to include not only the impacts in the economic and productive activities, but the impacts in the natural resources (deforestation, erosion), the impacts in security, the human health and the quality of life and, also other externalities of difficult economic valuation that include aspects of ecological regulation. Within these last ones the increase of greenhouse gases emissions coming from the degradation of the soil, microclimatic alterations, destruction of habitats, loss of biodiversity and of bank of genes, incidence of exotic diseases, loss in esthetic and psychological values of the landscape and in general diminution of the right to healthful natural surroundings, are all of then difficult to evaluate economically.

The difficulty of these valuations is obvious but some attempts or approaches exist. For example the losses due to the erosion of the soil, in the context of the European Union are considered equivalent to 15 billions of euro each year. Also in the EU the costs derived from salinisation processes are estimated in around 11 billions of euro per year. In Spain the environment ministry has considered that the direct damages and indirect cost of forest fires in the period between 1990 and 2005, are around 10 billion euro.

There is a need to raise awareness on the reality of the shortage of water and its connotations as an essential resource. There is also a need to improve the efficiency of operation of the entire hydrological infrastructure system.

An integrated vision of the cycle of the water is needed, e.g. applying tariffs and granting a price to the consumption of water would be probably the most effective measurement to promote effective water-saving policy, whenever these measures

are designed from a perspective of social fairness. Also it is possible to reassign strategic uses of the water in shortage situations, emergency or droughts, but always compensating economically to the sector to which temporarily it is deprived of its use. The precise application of desalination also offers important possibilities for the future, when we will most likely see new technological developments to improve efficiency and lower the economic cost and environmental impact.

A general plan for the prevention, adaptation and mitigation of the impacts of droughts, with a national and an international scope, is a deficiency that needs to be tackled given the Mediterranean climatic characteristics and the long registry of droughts of the past.

## Conclusions

There is a worrying trend in the perspectives of desertification, water scarcity and environmental security in the Mediterranean basin as a consequence of the evolution of global warming, demographic growth and mismanagement of the land. An anticipative approach of prevention and adaptation based on proactive international dialogue and co-operation is very much needed.

Efforts should be taken in order to change the way of thinking about nature and in our relationship with it. Those efforts should be based on increased scientific knowledge of Mediterranean nature functioning, its limitations and constrains. Interdisciplinary scientific research on the interactions of natural processes and human induced changes and conflicts is needed. Society should be more adequately informed for a more friendly use and management of natural resources.

There is an important field of activity and possibility of innovative responses and solutions in the social, technological and scientific sectors which could provide economic developments and alleviate pressures on the Mediterranean environment.

## References

Brauch, H.G. (2003) Security and Environmental Linkages on the Mediterranean Space: Three Phases of Research on Human and Environmental Security. In: Brauch, H.G., Liotta, P.H., Marquina, A., Rogers, P.F. and El-Sayed Selim, M. (Eds.) Security and Environment in the Mediterranean. Springer, Heidelberg.

Braudel, F. (1972) The Mediterranean and the Mediterranean World in the Age of Philip II, 2 volumes. Harper & Row, New York.

Buzan, B. (1998) Security: A New Framework for Analysis. Boulder, London.

European Communities (2006) Forest Fires in Europe 2005. European Commission, Joint Research Centre.

FAO (1996) The State of Food and Agriculture 1996. Food Security: Some Macroeconomic Dimensions. FAO. Rome.

Guillaume, B. and Comeau, A. (Eds.) (2005) A Sustainable Future for the Mediterranean: The Blue Plan's Environment and Development Outlook. Earthscan, London. 464 p.

Kirby, M.J. and Kosmas, C. (1999) Introduction. In: The Medalus Project: Mediterranean Desertification and Land Use. EUR 18882 EN, Office for Official Publications of the European Communities, Luxembourg.

Muller, H. (2002) Security Cooperation. In: Carlsnaes, W., Risse, T. and Simmons, B.A. (Eds.) Handbook of International Relations. Thousand Oaks, London.

NATO (1999) *Environment & Security in an International Context*. Committee on the Challenges of Modern Society. Report 232, Brussels.

Plan Bleu-UNEP (2006) A Sustainable Future for the Mediterranean: The Blue Plan's Environment and Development Outlook. Sophia Antipolis.

Rubio, J.L. (2007a) Mecanismos de retroalimentación entre desertification y cambio climatico. In: Cambio Climatico y sus Consecuencias. Presidencia de la Generalitat. Fundación Premios Rey Jaime, I (Ed.). Generalitat Valenciana.

Rubio, J.L. (2007b) Desertification y Cambio Climatico. *Ambienta*, 26–27, 70.

Rubio, J.L. and Recatala, L. (2006) The relevance and consequences of Mediterranean desertification including security aspects. In: Desertification in the Mediterranean Region: a Security Issue. Valencia NATO Workshop, Springer.

Rubio, J.L., Garcia-Novo, F., Baldasano, J.M. and Martin Mateo, R. (2006) Estrategia Mediteranea de Desarrollo Sostenible. Generalitat Valenciana.

Ullmann, R.H. (1982) Redefining Security. *International Security*, 8(1), 129–153. UNDP (1994) Human Development Report 1994. Oxford University Press, New York.

# Facing Water Crises and Shortages in the Mediterranean

**Henri-Luc Thibault**

## Introduction

In the Mediterranean rim countries, water resources are limited and very unequally distributed over space and time. Southern rim countries receive only 10% of the total precipitation.

Twenty million Mediterranean people do not have access to drinking water, particularly in the South and East. By 2025, the water-poor population – with less than $1,000\,m^3$ per capita per year – could increase to 250 million.

In a context of increasing shortages in parts of the region, and in view of the uncertainties brought about by climate change, the Blue Plan for the Mediterranean highlights the imperative need to adapt water management policies, to better manage the different uses and to ensure more optimal and effective use of resources, if present and future needs of populations and development are to be satisfied.

## Growing Pressures on Water Resources

During the second half of the 20th century, water demand, i.e. the amount of resource abstraction (95% of total withdrawal) plus unconventional production practices (desalination, wastewater reuse ...), including losses during transport and use (estimated at nearly 40% of total water demand!), has increased twofold, reaching $280\,km^3$/year in all riparian countries in 2005. Agriculture is the main water-consuming sector ($180\,km^3$/year to irrigate 24 million ha) and accounts for 64% of total water demand (45% in the North and 82% in the South and East), while it only remains marginal in the Eastern Adriatic countries.

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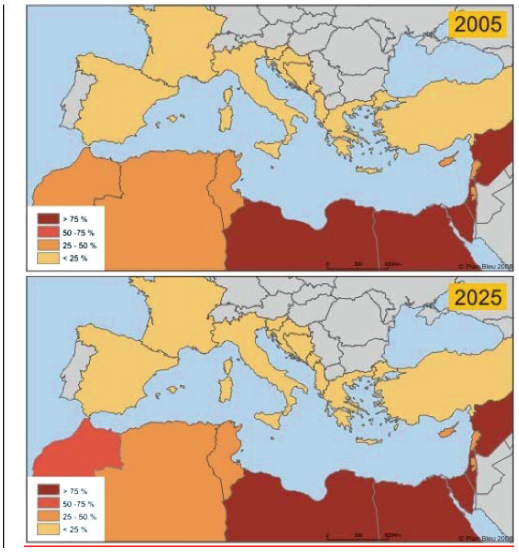


**Fig. 1** Exploitation index of renewable natural water resources, entire countries, 2005–2025
*Note:* Indices nearing or exceeding 75% reveal very strong pressures exerted on water resources; ratios between 50% and 75% point significant medium-term risks of structural stress; indices between 25% and 50% indicate that countries may endure local or fluctuating stress.
*source*: Blue Plan, 2005

By 2025, the significant increase in pressures on water resources, expressed by the exploitation index of renewable natural water resources, highlights strong and sometimes alarming contrasts as regards the "future of water" (Fig. 1). Today, in some countries (Egypt, Israel, Libya, Malta, Syria) and in Gaza Strip, water withdrawals already near or even exceed the limit threshold of renewable resources. The current and future situations are even more alarming when the index is calculated at Mediterranean catchment area rather than country level (which may hide large disparities within each country). Pressures on resources appear even greater when considering the only " exploitable " water resources which account for about one-third to a half of renewable natural water resources.

Water demand is increasingly met by an unsustainable water production estimated at 16 $km^3$/year, of which 66% coming from fossil water withdrawals and 34% from over-exploitation of renewable water.

The changes in temperature and rainfall described by the climate models will further aggravate these trends. The Mediterranean regions, which already suffer from serious water stress, will find themselves particularly exposed to a reduction in their water resource. Development along these lines could give rise to acute crisis situations in some countries. With demographic growth, in the South and East of the Mediterranean, the population of countries facing water shortages has been estimated at 290 million in 2050.

Pressures can also be qualitative. Many aquifers, particularly in the North, show excessively high contents of pesticides or nitrates. Forty-seven million Mediterraneans are deprived of access to improved sanitation systems, mainly in the South and in the Middle East. And everywhere, many rivers are subjected to chronic pollution due to non-treated domestic and industrial discharges.

## Water Demand Incompatible with Resource Availability

According to the projections of the Blue Plan trend (baseline) scenario, water demand may increase by a further 50 $km^3$ (+18%) by 2025. Most of this growth would be in the Southern countries (+28%) and even more so on the Eastern shore (+33%), particularly in Turkey and Syria (Fig. 2). In some cases, nevertheless, the growth in water demand is likely to be slowed by reduced availability and adaptation of use (Israel).

Agriculture is expected to remain the main water user in volume, for water resource to satisfy irrigation requirements, in particular in the South and East. According to FAO, irrigated surfaces could increase by 38% in the South and by 58% in the East by 2030, whereas in the North, water demand for agriculture would remain stable and even decline (Italy).

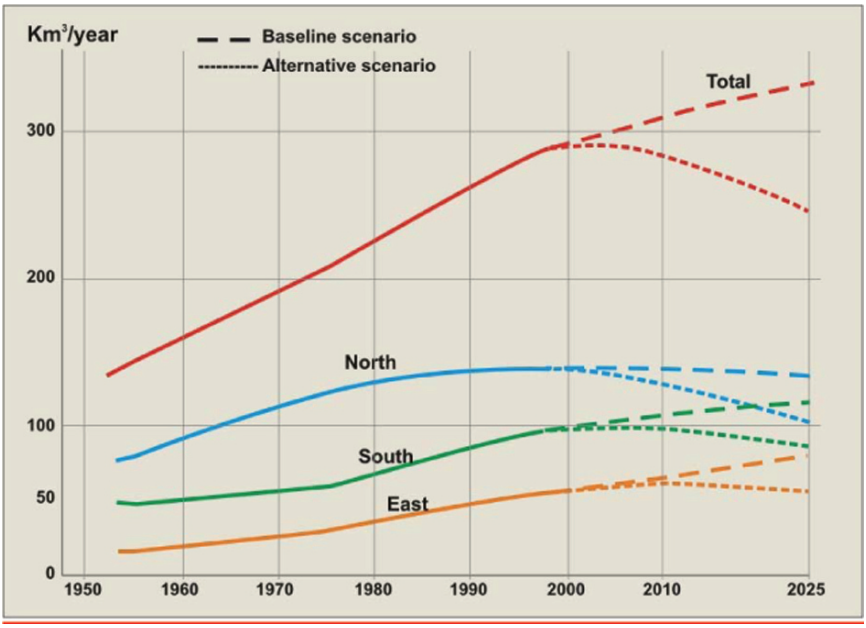


**Fig. 2** Total water demand, trend (baseline) and alternative scenarios (entire countries) (*source*: Blue Plan, 2005)

Growth in drinking water demand is also expected to continue, to satisfy the needs of ever-larger urban populations – additional 98 million urban residents are expected in the South and East by 2025 – and ever-expanding tourism (300 million tourists per year forecast around 2025).

The water requirements of the energy and industrial sectors should decrease in absolute terms in the Northern Mediterranean countries, particularly because of the expected efficiency gains. In the South and East, on the other hand, the industrial demand is set to increase strongly in absolute value and reach more than 7% of the total demand in 2025.

Although it remains difficult to quantify, the environmental demand, required particularly for the proper functioning of ecosystems, could expand. Some countries have already incorporated minimum watercourse flow for the survival of species into their legislation, as in the European Union with the Water Framework Directive, or have explicitly provided for an environmental demand (Spain), and others may follow (Cyprus, Israel, Morocco, Tunisia, etc.). But more often, this demand is not quantified in the water balance but is rather considered to be a limit to the exploitation of resources.

## Water Policies Still Excessively Focused on Supply

To meet growing demand, national strategies essentially rely on the extension of water supply and on major waterworks to enhance resource management and reduce risks resulting from natural constraints. There are already 1.200 large dams recorded in the sole Mediterranean watershed area. The supply-based approach is expected to remain prevalent and lead to the following consequences (Fig. 3):

- Increased withdrawal of renewable resources through major hydraulic projects, overexploitation of underground water and development of interregional and international transfers.
- Increased “mining” exploitation of non-renewable underground water resources in the Saharan basins of several Southern Mediterranean countries. Such excessive abstraction may more than double by 2025, particularly in Libya and Algeria.
- The use of return water from agricultural drainage (Egypt) and the reuse of treated wastewater for irrigation (Spain, Israel, Cyprus, Egypt, Tunisia).
- Industrial production of fresh water by desalination of seawater or brine which, having first developed in isolated island situations (Malta, Balearics, Cyprus) and on the coast (Libya), particularly to meet the needs of the tourist sector, is now burgeoning all round the Mediterranean. It constitutes up to 60% of the drinking water supply in Malta. Algeria, which disposes of cheap energy, is clearly banking on desalination to supply its major urban centres with water (Algiers, Oran, Skikda). Spain, the fourth producer worldwide, particularly assigns a large part of the desalinated water to the agricultural sector for off-season market gardening or truck farming under glass for export. The total capacity installed in the Mediterranean could be multiplied by 6 by 2030, to reach nearly 30 million $m^3$/day.

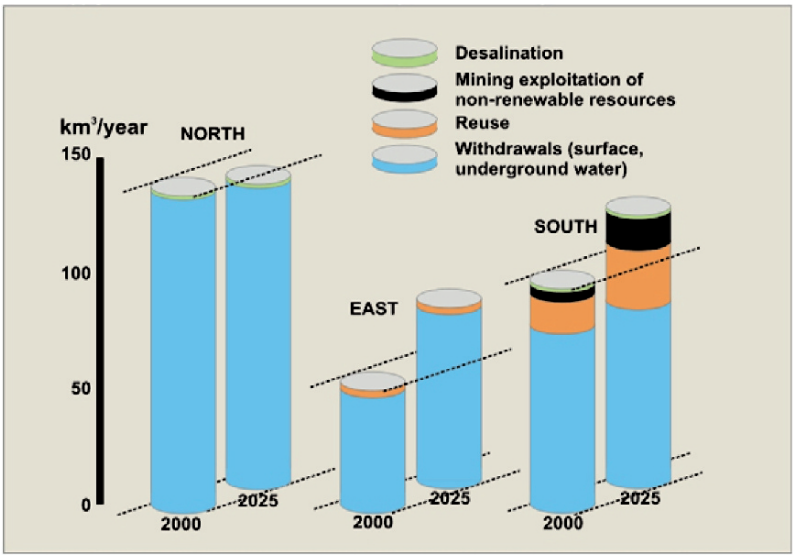


**Fig. 3** Water supply sources in Mediterranean countries (trend scenario) (*source*: Blue Plan, J. Margat, 2004)

As regards the supply, note that the cost of desalination has fallen significantly, making this resource more competitive than transfers. Large-scale desalination nevertheless remains an option which consumes much energy, emits greenhouse gases and is expensive. The cost of water produced by desalination of seawater is thus of the order of 0.4 to 0.6 euros/$m^3$ for major units, i.e. about twice as much as "conventional" water, without taking into account the large initial investment. Desalination also has negative impacts on the environment due to the development of coastal infrastructures and the discharge of brine.

The continued application of policies focused on extending supply and pursuing abstraction, using and constantly deteriorating natural resources, represents severe risks in the long-term, such as the rapid depletion of some fossil resources, the destruction of coastal aquifers through seawater intrusion, the degraded quality of water and aquatic systems, reduced flows and the drying-up of wetlands. The factors of increasing "water vulnerability" (production costs, conflicts, sanitary risks) could be aggravated. Supply-based policies are therefore reaching physical, socio-economic and environmental limits, as demonstrated in the South and East by the current condition of dams, where silting will probably reduce most of their capacity. It is estimated that the entire Maghreb loses the equivalent of a reservoir of 100 million $m^3$ every year in this way.

## Saving a Quarter of Water Demand

In order to counter the trend scenario with its inevitable crises, an alternative scenario is possible (Blue Plan, 2005), based on proactive policies:

- For the efficient and economic use of water, by putting in place technical, economic, regulatory or social instruments for demand management
- To increase the exploitable potential through improved water and soil conservation, and increased recourse to the artificial replenishment of water tables in arid countries (to favour infiltration and storage in the aerated portion of the soil or in aquifers and thus to reduce evaporation losses)

There is considerable room for progress since improved water demand management would make it possible to save 25% of water demand, i.e. approximately 85 $km^3$/year in 2025 (Figs. 2 and 4). Irrigated agriculture represents the largest potential for volume savings, with nearly 65% of total water potential savings identified in the Mediterranean (transport losses reduced by 50%, down to 10%, irrigation water efficiency increased from 60% to 80%). A further 22% in water savings potential can be expected from industry (recycling rate up to 50%), and another 13% from drinking water supply (transport losses and household leaks reduced by 50%, respectively down to 15% and 10%).

According to this optimistic view, assumed to be generalized throughout the Mediterranean countries, total water demand would level off at 102 $km^3$/year in the North and at 144 $km^3$/year in the South and Middle East, globally equivalent to the drop in total current demand of approximately 40 $km^3$/year (Fig. 2). These water savings would also allow energy savings and financial economies. Analyses which have been made show divergences, of 1 to 3 or of 1 to 10 in different cases, between the cost of a cubic meter of saved water and that of a cubic meter of exploited water.

These global estimates, based on concrete experiences carried out in certain countries (see box), show that current trends can be inverted.

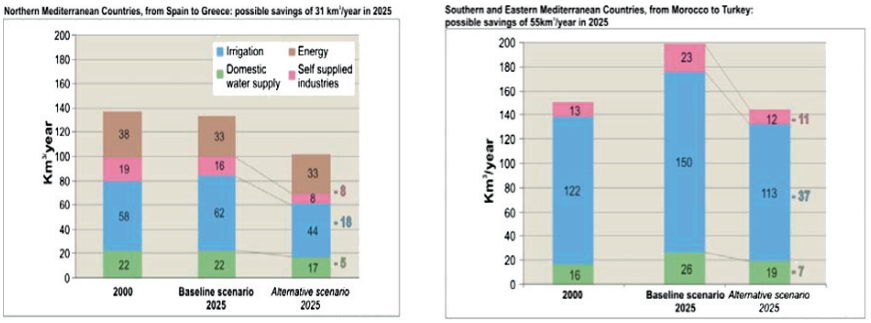


**Fig. 4** Water demand per sector of use, trend and alternative scenarios, entire countries (*source*: Blue Plan, J. Margat, 2004)

**Water-Saving Policies in Tunisia and Morocco**

Tunisia has implemented a national water-saving strategy for irrigation, which includes the creation of user associations, pricing aimed at progressive cost recovery, targeted financial instruments for water-efficient farming equipment, and support to farmer revenues. Since 1996, this policy has stabilized irrigation water demand despite agricultural development, and the needs of both the tourism sector (a source of foreign currency) and cities (a source of social stability) have been assured.

In Morocco, increasing water demand in the Rabat-Casablanca conurbation has been greatly slowed down over the last 15 years, in spite of serious urban expansion. Improved water management (reduction of leaks from the network, progressive pricing, systematic metering, intense user awareness campaigns) has made it possible to delay or even to cancel certain major investment projects (dams, transfer canals) which were initially included in the 1980 master plan while still meeting needs. These investments, which would be difficult to finance without increasing the public debt, might prove ultimately superfluous.

The challenge of water demand management is not only limited to physical savings. It also means improved economic and social enhancement of mobilized resources and the coverage of water requirements of ecosystems. In Northern rim countries, rather better endowed with water and where demand is falling, resource quality is prevalent, on a par with the interest in maintaining or restoring ecosystems, generating lesser water supply costs. In the South and East, where countries are facing both the squeeze from limited water resources and the rapidly increasing demand, quantitative aspects are still the main issue.

## The Necessary Reforms to Invert Current Trends

Water shortages are already occurring in parts of the Mediterranean region, and will inevitably spread and worsen in the 21st century, particularly in the South and the East. The countries where the water resources are the lowest per capita and most costly to mobilise and distribute will see the greatest increases in demand, and face the greatest risk of their resources shrinking. This will require them to make great efforts to adapt to the new Mediterranean situation.

The room for manoeuvre when setting water policies in the Mediterranean region is not large, but it is real. These policies must be rebalanced by moving from the supply approach, which has long been predominant, towards demand management.

The transition from the baseline scenario to a sustainable development scenario can only be gradual, carried by the indispensable policy reforms posting clear integrated water resource management objectives in all policies – particularly in

agricultural ones – and generating the means for implementation, based on the development of sustainable efficiency plans and financial mechanisms.

In this context, both the financing of investments in drinking water supply and sanitation infrastructures (in the South and East) and the recourse to economic instruments such as subsidies and pricing to optimise allocation of available resources, appear crucial for the future. The same applies to strengthening management capability, particularly at the local level. Regional cooperation, based on a long-standing tradition in water in the Mediterranean, can certainly contribute as catalyst to accelerate the emergence of the required changes.

Thus, in the framework of the Mediterranean Strategy for Sustainable Development, the Mediterranean rim countries have set the following priority objectives:

- To stabilise water demand through the reduction of water losses and the wasteful use of water and increase the added value per cubic metre of water used
- To promote the integrated management of watersheds
- To achieve the Millennium Development Goals concerning access to safe drinking water and sanitation
- To promote participation, partnership, active cooperation and solidarity for the sustainable management of water, at the local and the national level

## References

Blinda, M., Thivet, G., Plan Bleu (2007). *Améliorer l'efficience d'utilisation de l'eau pour faire face aux crises et pénuries d'eau en Méditerranée*. Synthesis note. www.planbleu.org.

FAO (2000). *Agriculture*: *toward 2015/2030*, Global perspective studies unit, April.

Margat, and Plan Bleu (2004). *L'eau des Méditerranéens*: *situation et perspectives.* Athens, MAP Technical Report Series no 158. www.unepmap.gr.

Plan Bleu (2005). *A Sustainable Future for the Mediterranean. The Blue Plan's Environment and Development Outlook*, edited by Guillaume Benoit and Aline Comeau. London: Earthscan. Chapter on "Water", pp. 69–108. www.planbleu.org.

UNEP/MAP/Plan Bleu (2007). *Water Demand Management, Progress and Policies.* Proceedings of the 3rd regional workshop on water and sustainable development in the Mediterranean, Zaragoza, Spain, 19–21 March 2007. Athènes. MAP Technical Reports Series, no. 168. www.unepmap.gr.

# Reviewing Land Use and Security Linkages in the Mediterranean Region

**W.E.H. Blum**

**Abstract** Impacts of land degradation, desertification and water scarcity in the Mediterranean region on technical, social, economic and cultural environments are discussed under security aspects, including additional risks caused by climate change, and possibilities of mitigating security problems by bridging between science, politics and decision making.

## Introduction

Before reviewing land use and security linkages, it seems necessary to define some of the basic terms.

"Land" normally means a physical entity in terms of its topography and spatial nature, including natural resources such as soils, minerals, water and biota, that the land comprises (UNEP, 2001). Soils are part of land, forming the uppermost crust of the earth.

Under "land use" three ecological and three technical, social and economic uses can be distinguished (Blum, 2005; Frossard et al., 2006).

The ecological uses are

- Production of biomass, ensuring food, fodder, renewable energy and raw materials through landscaping, agricultural and forest activities, gardening, and others.
- Collection of rainwater, filtering, buffering and transforming it into ground water or even drinking water resources. Moreover, all solid, liquid and gaseous, inorganic and organic compounds, e.g. pollutants deposited on land can be mechanically filtered, physico-chemically buffered and microbiologically and biochemically transformed by soils, thus protecting the food chain, as well as the ground water against contamination.

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– Soil as a biological habitat and an enormous reserve of genes, larger than all above ground biota together, and therefore most important for the maintenance of biodiversity and the biological functioning of terrestrial ecosystems.

The three technical, industrial and socio-economic functions comprise

– Land as a physical base for technical, industrial and socio-economic structures and their development, e.g. industry, housing, transport, sports, recreation, dumping of refuse etc.
– Land and soil as a source of raw materials, such as clay, sand, gravel and others, for implementing such structures, as well as a source of water and geogenic energy
– Land and soil as a geogenic and a cultural heritage, forming an essential part of the earth's surface and concealing palaeontological and archaeological remnants of high importance for the understanding of the history of the earth and of humankind

These six main uses are shown in Fig. 1. From this figure, it becomes evident that we are simultaneously using all these functions, which causes problems through the competition between the uses.

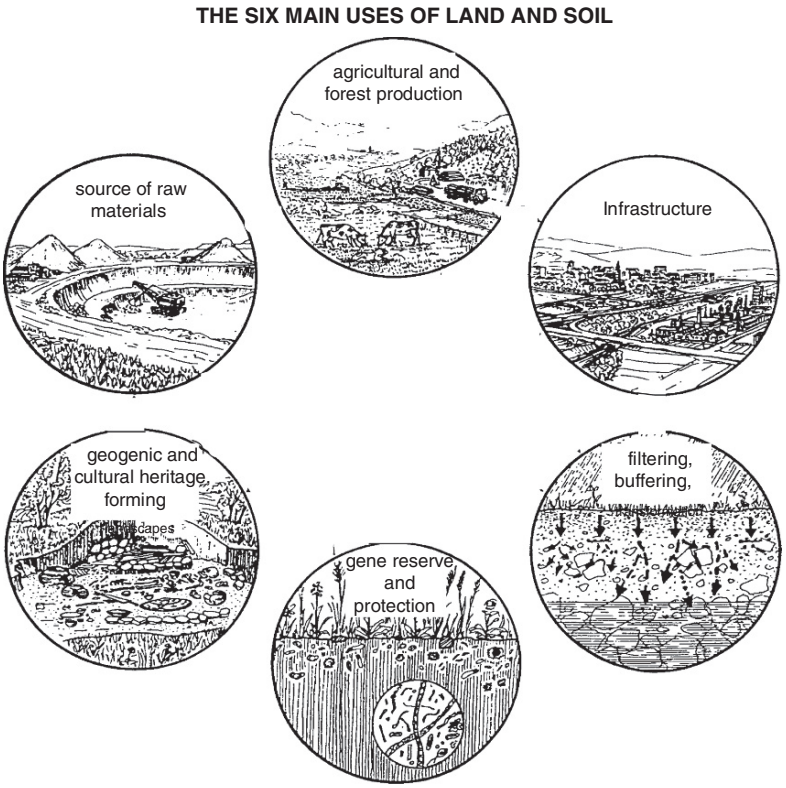


**Fig. 1** The six main uses of land and soil

"Security linkage" means that security problems can arise from two different kinds of impacts:

- **Natural environmental events**, e.g. natural disasters, such as extreme meteorological conditions, forest fires, landslides and others
- **Human induced environmental impacts**, such as the depletion of natural resources, especially of soil and water, the loss of biodiversity, the sealing of land by urbanisation, industrialisation and tourism, and as an overall result of human activities, the climate change, which is the global result of innumerable locally defined processes

In the following, mainly human induced impacts will be discussed, which are mostly complex and show environmental, technical, social, economic and also cultural dimensions.

For impacts as well as for security problems, two parameters are of paramount importance:

- The dimension of space, which means the spatial scale, e.g. of urbanisation, of soil contamination, landslides, forest fires and others.
- The dimension of time, which means the pace with which the impact-driven processes occur. For example, it is very important if sealing of large areas by urbanisation occurs within a few years or in decades.

Two types of security linkages will be discussed in more detail:

- Security problems resulting from land degradation and desertification
- Security problems deriving from water scarcity

## Security Problems Caused by Land Degradation and Desertification

### *Land Degradation*

Land degradation is mainly caused by two types of unsuitable land use:

- Use of land which excludes all the other uses, e.g. sealing of land through urbanisation
- Unsustainable use of single land functions, e.g. unsustainable agricultural land use or industrial activities causing emissions of toxic compounds

The exclusive competition between the six functions and uses of land becomes visible by comparing Europe's natural resources at daytime with Europe's built environment at night, showing that large parts of Europe are sealed by urbanisation, industrialisation and transport, from which emissions are released on the adjacent land surfaces (see Figs. 2 and 3; Blum et al., 2004).

**Fig. 2** Europe's natural resources

Figure 4 gives a detailed view on the increase of artificial area in coastal zones between 1975 and 1990 in percentage and the projected increase in urban population between 1990 and 2025 (EEA, 2001). These pictures indicate that sealing is impeding all other land uses, the ecological as well as the technical, social and economic ones. Figure 5 shows in more detail the process of sealing of a landscape in southern Germany, with towns, villages and roads of first and second order, connecting urban and peri-urban settlements at a scale which is indicated in the picture.

Sealing at large extent is typical for urban agglomerations, taking Cairo, the largest city of Africa, as an example (see Fig. 6).

Security problems caused by sealing, e.g. urbanisation, industrialisation, transport and tourism are twofold:

1. Ecological–technical problems are:
   - Impedance of rainwater infiltration, causing surface runoff, with the danger of flooding and the loss of rainwater storage in areas where this water would be urgently needed

**Fig. 3** Europe's built environment

- High evaporation and water losses to the atmosphere from urban surfaces, sealed by asphalt, concrete and other dense material, e.g. roofs, streets, parking lots etc.
- Increased temperature levels, due to storage of radiation energy in the constructions
- Production and accumulation of refuse and emission of dust and gases
- Increased demand for water, in competition with other uses, e.g. agriculture

Therefore, large touristic areas in the Mediterranean Basin can cause security linkages.

2. Social, economic and cultural constraints are caused by:

- The disappearance of natural landscapes, formerly used for agriculture or forestry
- Loss of livelihood through the loss of crop and pasture land
- Emergence of new social groups with problems of integration into the existing social and economic environments

Besides sealing as an exclusive form of competition, urban and peri-urban agglomerations cause important impacts through physical and chemical loads on the adjacent agricultural and forest lands, on the atmospheric pathway, on the waterway

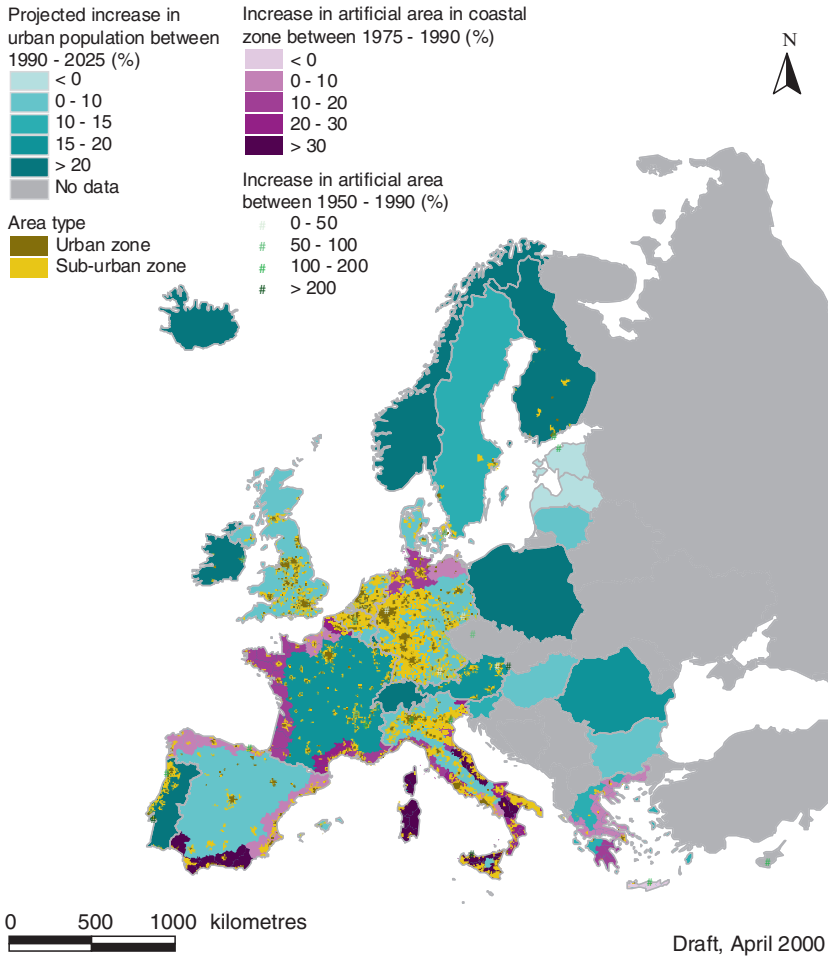


**Fig. 4** Land use changes in coastal areas and projected increase in urban population (EEA, 2001)

and through terrestrial transport (see Fig. 7). These processes are still going on and were even accelerating in the last decade, contaminating land and water surfaces with heavy metals and toxic organics in an intensity which never existed before (Blum, 1998, 2006).

The impact of urban agglomerations on the adjacent agricultural land is shown in Figs. 8–11. The flow of goods through Vienna in tons per day (Fig. 8), is evidence to the fact that even cities like Vienna, with a very low level of industrial activity need high amounts of water and air per day, producing sewage and off-gas and are accumulating each day about 35,000 t of construction materials, disposals and durable goods within the city area.

Looking only at the flow of copper in tons per year (Fig. 9), reveals for a city like Vienna, which may have a total stock of 320,000 t of copper contained in roofs,

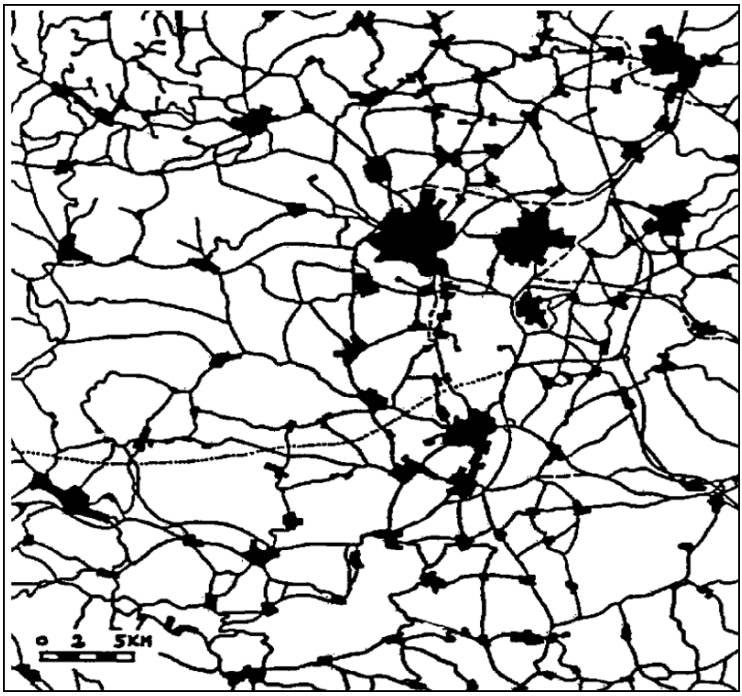


**Fig. 5** Sealing of soils and landscapes by settlements and roads, observe the scale in the left lower corner (e.g., south-western part of Baden-Württemberg, Germany)

**Fig. 6** View of Cairo from the citadel (*Photo:* Blum, 2002)

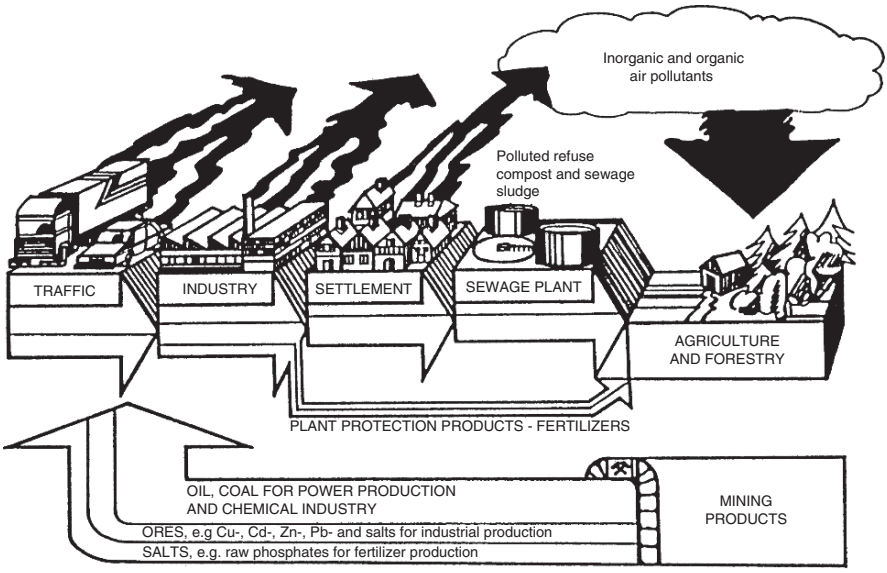


**Fig. 7** Contamination of land and soils through excessive use of fossil energy and raw materials (Blum, 1998)

tiles, tubes and other construction materials, that every year 8,000 t of Cu are added, of which only a small portion is leaving the city as off-gas (about 1 t), in the sewage (about 10 t) and as solid waste (about 100 t). About 7.889 t remain in the city, which becomes with time a "chemical time bomb".

Analysing the distribution of copper in the surroundings of Vienna shows a clear impact of the city on the adjacent agricultural areas east of Vienna, for which the soil sampling sites for copper analysis are shown in Fig. 9. The soil analytical data reveal a clear relationship between the distance from downtown Vienna and the copper content of the uppermost soil horizons (0–20 cm), which can be seen in Fig. 10.

Even considering that this degree of contamination is not alarming, it clearly shows the impact of urban activities, which is also visible for zinc in the same figure. Zn is used for protecting all kinds of ferric material against rusting. In conclusion, cities are not only areas of high accumulation and turnover of goods, but also sources of contamination for the adjacent environments.

Such and similar impacts can trigger conflicts, see also the deposition of refuse from urban agglomerations, which normally occurs somewhere in the adjacent surroundings.

Further impacts of land use can be caused by unsustainable agriculture. Figure 12 shows impacts on soil through compaction, accumulation of contaminants, e.g. pesticides, through the use of manures and fertilisers, sewage sludge deposition, through soil erosion, loss of organic matter and others (Blum, 2007a). Unsustainable agricultural land use through the centuries can ruin entire landscapes, as can be seen in a landscape in North Africa, see Fig. 13.

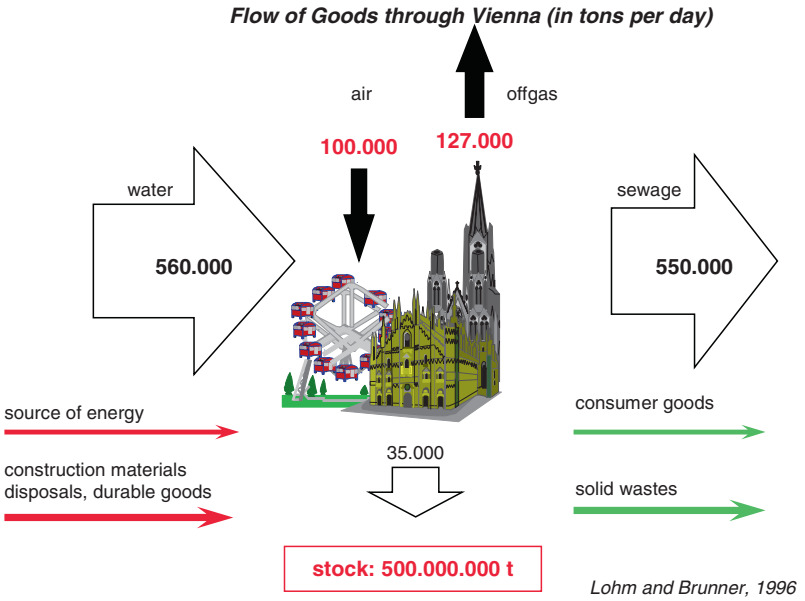


**Fig. 8** Flow of goods through Vienna in tons per day (Blum, 1998)

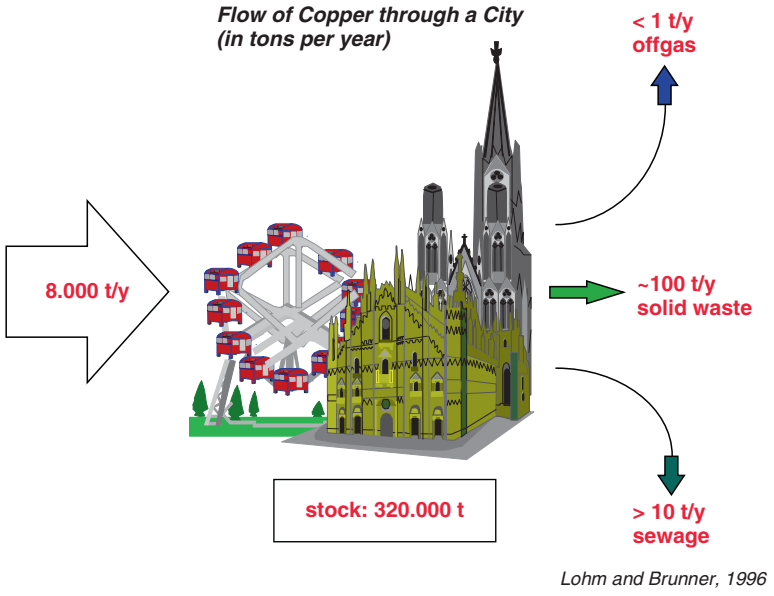


**Fig. 9** Flow of copper through a city (in tons per year) (Blum, 1998)

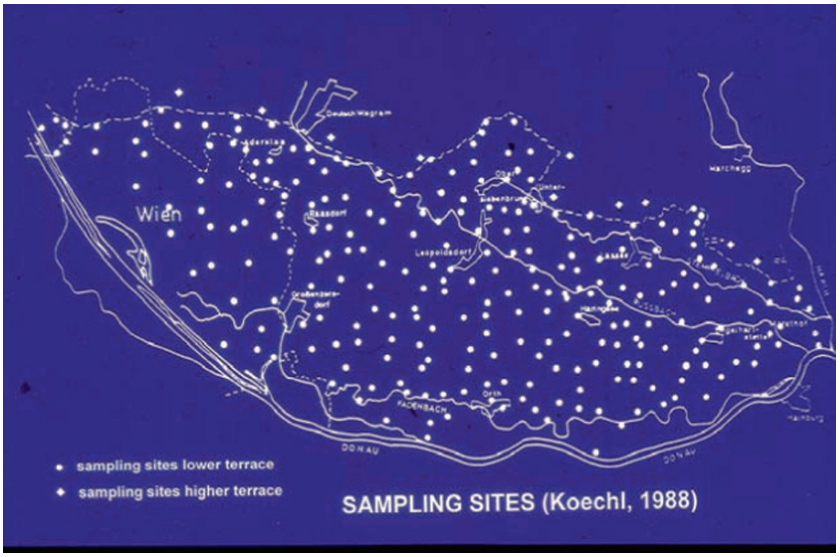


**Fig. 10** Soil sampling sites east of Vienna (Blum, 1998)

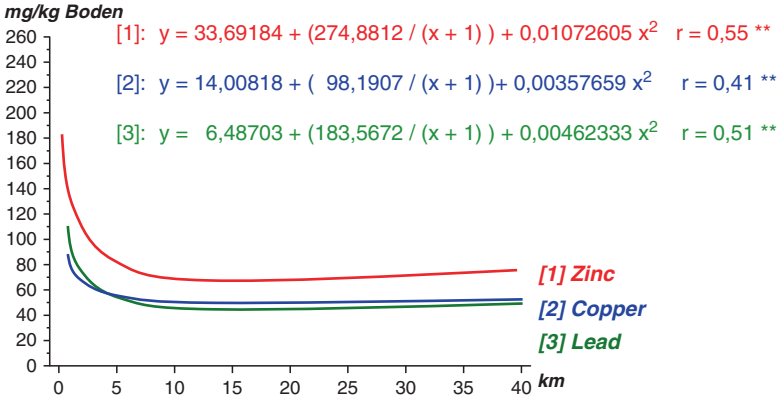


**Fig. 11** Heavy metal contents in agricultural topsoils (Blum, 1998)

## *Desertification*

Desertification is a special form of land degradation, occurring under arid and semi-arid climatic conditions, characterized by a lack of rainfall during long periods of the year and a deficit in the annual water balance. Those areas are specifically vulnerable to land degradation caused by forest fires, overgrazing, agricultural cropping, or urbanisation and industrialisation (Blum, 2006).

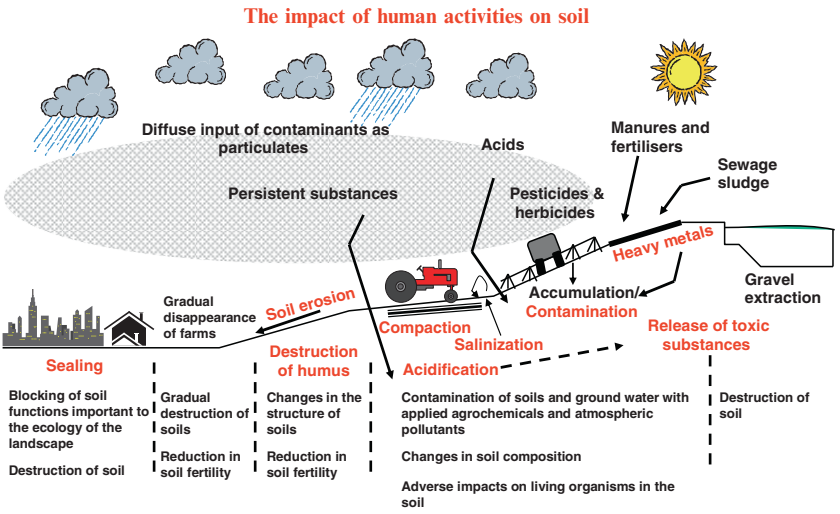


**Fig. 12** Impact of human activities on soil (IES, JRC, Ispra)

**Fig. 13** Soil erosion control in bad lands (Photo: Blum, 1986)

A special problem in areas with water deficit is salinisation through irrigation without sufficient drainage. Further problems occur through imbalanced water availability in upstream and downstream areas of water reservoirs. People upstream often have limitations in land use in order to avoid erosion and sedimentation of the water reservoir, whereas people downstream are profiting from the water accumulated by

the dams. Under such conditions, conflicting interests exist, which have to be solved by politics and decision making.

Recently, new conflicts arose through the competition between the production of food and biofuels, such as ethanol and biodiesel, aggravated through water scarcity, as water is needed for both production lines.

### *Classification of Impacts in Order of Urgency*

Classifying impacts in order of urgency, shows that land and soil losses through sealing, mining of soil materials, soil erosion by water and wind, as well as intensive pollution of soils by heavy metals, xenobiotics, radioactive compounds, by advanced soil acidification and salinisation and deep reaching soil compaction are irreversible. Irreversible means that these damages cannot be reversed in a time span of about 100 years or four human generations.

In contrast, reversible damages or threats are soil pollution by biodegradable organic compounds, and problems due to superficial compacting, glazing and other physical deterioration of topsoil structures, see also Blum (2007b).

This classification is important for defining priorities in combating security problems which may increase or accelerate with time, thus causing large scale security issues.

## Security Problems Related to Water Scarcity

Water scarcity is typical for countries of the Mediterranean Basin, due to its specific climatic conditions. Competition in the use of the scarce water resources already exists in areas with intensive agricultural irrigation, which consumes on the average more than 70% of all available water resources and leaves only 30% or less for domestic and industrial purposes, not counting the high water losses though deficient water distribution systems such as pipes, where often up to 25% of all available water is lost.

Under those conditions, touristic activities during the dry season with high demands for water come into in conflict with the need of the local population especially for gardening and agriculture. Moreover, unsustainable water use through agriculture, e.g. with insufficient irrigation techniques cause loss of water reserves and salinisation, with additional adverse impacts on estuarine and coastal environments.

In some Mediterranean regions, we observe increasingly that rivers are no longer deserving the groundwater resources. On the contrary the groundwater resources are providing water for the rivers, which is a strong signal that the water balance in these regions is heavily disturbed.

These processes are part of the desertification and can raise severe security issues, because under the prevalent and possible future climatic conditions, the results may become irreversible and may therefore endanger the living basis of large parts of the population.

## Climate Change and Future Risks

Looking into the IPCC scenarios up to 2100, it becomes clear that not only the $CO_2$ emissions, but also the $CO_2$ increase in the atmosphere and the resulting temperature rise are severe threats, see Fig. 14, especially to the Mediterranean region, see also Steffen et al. (2004).

Specific changes are shown in Figs. 15 and 16, indicating the mean annual temperature changes for 2071–2100, relative to 1990, as well as the change in the mean annual precipitation for the same time period (IPCC, 2001). These figures reveal that the mean annual temperature of the Mediterranean Basin will increase, whereas the mean annual precipitation will decrease.

Considering the share of irrigated land in arable land in the Mediterranean Basin (Fig. 17), makes clear that in the Mediterranean Basin several countries, e.g. Egypt, which is nearly totally depending on irrigation, will severely suffer from the decrease of water reserves, see also Parry et al. (2004).

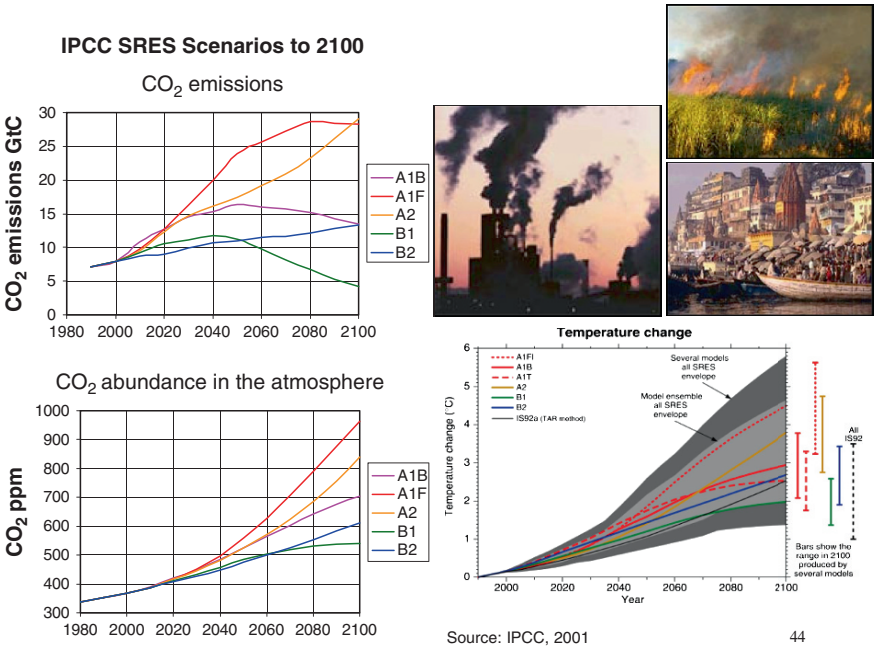


**Fig. 14** IPCC SRES scenarios to 2100 (IPCC, 2001)

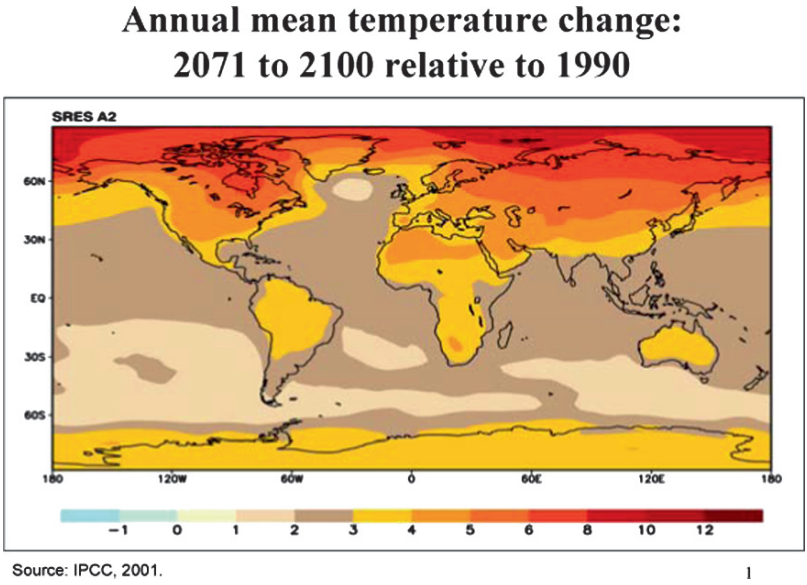


**Fig. 15** Annual mean temperature change: 2071 to 2100 relative to 1990 (IPCC, 2001)

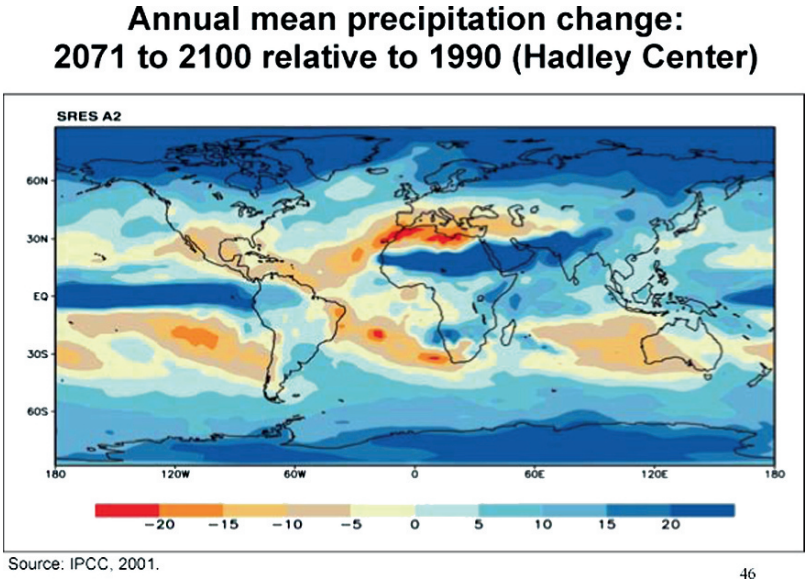


**Fig. 16** Annual mean precipitation change: 2071 to 2100 relative to 1990 (IPCC, 2001)

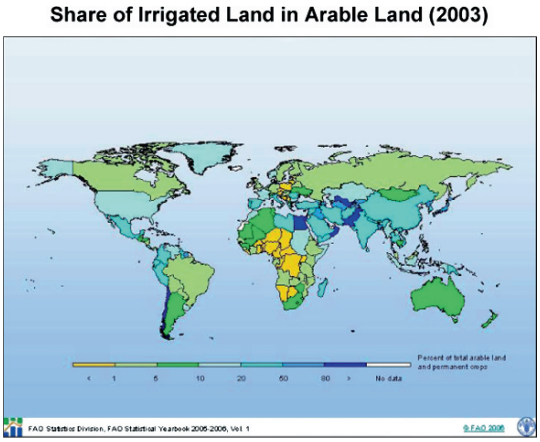


**Fig. 17** Share of irrigated land in arable land (FAO, 2006)

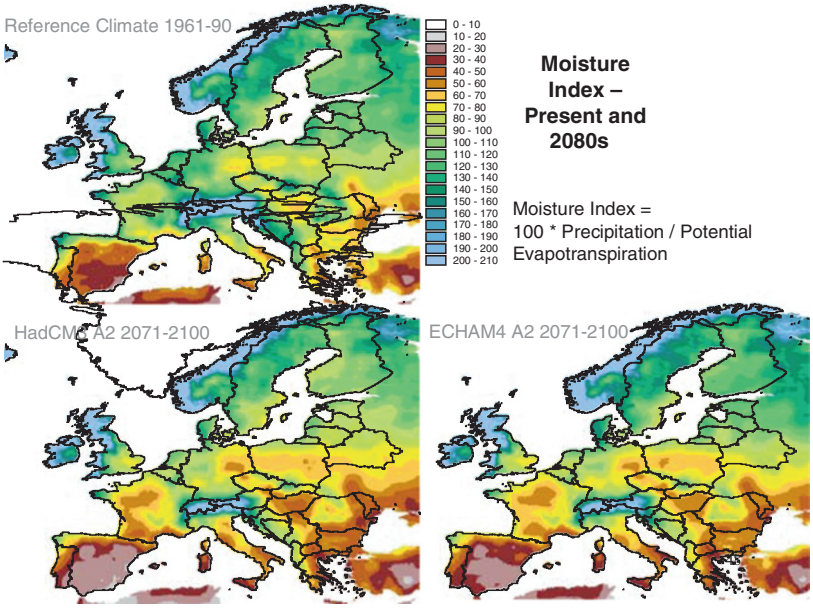


**Fig. 18** Moisture index of Europe – present and 2080s (Fischer et al., 2005)

Looking into the moisture index from present to 2080 (Fig. 18), reveals clearly that the Mediterranean Basin will become dryer in the next decades, which means that conflicts about water availability may arise due to the increase of water scarcity.

## Solving Security Issues by Bridging Between Science, Politics and Decision Making

Impacts on social and economic systems caused by land use and water scarcity and resulting conflicts have to be controlled by politics and decision making.

However, sustainable use of land, e.g. through spatial and/or temporal harmonisation of the uses in a given area, avoiding or minimising irreversible impacts, as well as the socially and economically balanced distribution of water resources is not a scientific but a political issue (Blum, 2006, 2007a, b). Two decision patterns can be distinguished:

- Top–down decisions, in which the top-ranking deciders are managing the basis
- Bottom–up approaches, in which the local population formulates its demands and asks the leaders to take action

As expressed before, all land use and water scarcity issues are complex, showing ecological, technical, social, economic and cultural dimensions. Therefore, it is necessary to define indicators which can be used as information basis for understanding and managing these complex systems. Such indicators can be cultural, social, economic or technical ones. Examples for ecological indicators are: soil quality, water quality, biodiversity, human health and others; technical indicators: access to the land, availability of tools and others; social and economic indicators: economic wealth and access to social resources; a cultural indicator could be the educational level in a region (Blum, 2004).

The criteria for those indicators are fourfold:

- They must be policy-relevant and focus on real demands.
- They must by analytically sound, based on science and revealing a clear cause–response relationship.
- They must be easy to interpret and understandable for farmers and stakeholders at the grass-roots level, as well as for decision makers and politicians.
- They must be easily measurable and therefore feasible and cost effective in data collection, data processing and dissemination.

With the help of indicators, it should be possible to mitigate and alleviate future security problems, thus diminishing security linkages caused by land use and water scarcity in the Mediterranean region.

## References

Blum, W.E.H.: Soil Degradation Caused by Industrialization and Urbanization. In: Blume H.-P., H. Eger, E. Fleischhauer, A. Hebel, C. Reij, K.G. Steiner (Eds.): Towards Sustainable Land Use, Vol. I, 755–766, Advances in Geoecology 31, Catena Verlag, Reiskirchen 1998.

Blum, W.E.H.: Soil Indicators for Decision Making – Sharing Knowledge Between Science, Stake Holders and Politics. Thirteenth International Soil Conservation Organisation Conference, 4–8 July 2004, Brisbane/Australia – Conference Proceedings (CD), Paper No. 202, pp. 1–5, Brisbane 2004.

Blum, W.E.H.: Functions of Soil for Society and the Environment. Reviews in Environmental Science and Biotechnology 4, 75–79, 2005.

Blum W.E.H.: Urban and Peri-Urban Environments: Emerging Frontiers in Soil and Water Conservation. E.S.S.C. Newsletter 3, 16–23, Wolverhampton/UK, 2006.

Blum, W.E.H.: Role of Soils in River Basin Management. RiskBase 1st Thematic Workshop, 17–18 May 2007, Lisbon, Portugal, pp. 15–18, IIQAB-CSIC, Barcelona, Spain 2007a.

Blum, W.E.H.: From Vulnerability to Resilience – Search for New Concepts, Explaining the Need for Integrated Risk-Based Management of the Water-Sediment-Soil System at River-Basin Scale. RiskBase-Newsletter 1, p. 2, October 2007, TNO, Utrecht/NL, 2007b.

Blum, W.E.H., Barcelo, D., Büsing, J., Ertel, T., Imeson, A., Vegter, J.: Scientific Basis for the Management of European Soil Resources. Research Agenda, 18 pp., Verlag Guthmann-Peterson, Wien 2004 (ISBN 3-900782-47-4).

EEA: Environmental Signals 2001. Environmental Assessment Report No. 8. European Environment Agency, Copenhagen, 2001.

FAO Land and Water Digital Media Series 11: Global Agro-Ecological Zones, Version 1.0, IIASA Science for Global Insight, 2006

Fischer, G., Shah, M. Tubiello F.N., Van Velhuizen H.: Socio-Economic and Climate Change Impacts on Agriculture: An Integrated Assessment, 1990–2080. Philosophical Transactions of the Royal Society B 360, 2067–2073, 2005, doi:10.1098/rstb2005.1744 Published online.

Frossard, E., Blum, W.E.H., Warkentin, B.P. (Eds.): Function of Soils for Human Societies and the Environment. Special Publication No. 266, Geological Society, London, 2006 (ISBN 978-1-86239-207-6).

Parry, M.L., Rosenzweig, C., Iglesias, A., Livermore, M., Fischer G.: Effects of Climate Change on Global Food Production Under SRES Emissions and Socio-Economic Scenarios. Global Environmental Change 14, 53–67, 2004.

Steffen, W., Sanderson, A., Tyson, P.D., Jäger, J., Matson, P.A., Moore, III B., Oldfield, F., Richardson, K., Schellnhuber, H.J., Turner, II B.L., Wasson, R.J.: Global Change and the Earth System – A Planet under Pressure. Springer, Berlin, Heidelberg, New York, ISSN 1619-2435, ISBN 3-540-40800-2, 2004.

UNEP: Global Ministerial Environment Forum Policy Issues: State of the Environment – UNEP's Policy on Land and Soil. UNEP/GC21-IDF-13, January 2001, Nairobi.

# Part II
# Reports of the Workings Groups

# WG I – SECURITY IMPLICATIONS OF UNSUSTAINABLE WATER MANAGEMENT AND LAND USE

**Facilitators: Prof. Uriel Safriel and Prof. Winfried E.H. Blum**
**Rapporteur: Vicente Andreu**

Participants addressed the severity of water shortage and land degradation in their respective countries, commended themselves for the actions taken by their countries to respond to water shortage and land degradation problems, and (in the case of developing countries), made a plea for support, with implications of support that is financial. The need to better understand the difference between "environmental degradation" and loss of "environmental security" was highlighted.

The Conceptual Framework of the Millennium Ecosystem Assessment was presented, in which soil conservation, land productivity and water resource provision and regulation are viewed as ecosystem services, which provide for "Human Well-Being", whose major component is "security", meaning personal safety, secure resource access and security from disasters. Desertification and land degradation can therefore be viewed as failure of ecosystems to provide the above services. This failure is driven by direct drivers (biophysical) such as soil erosion and salinisation, water pollution, etc. which in turn are driven by indirect drivers (social, economic, demographic, political, governance, etc.). The latter interact with human well-being. Namely, economic and social factors determine human well-being, including security, but human well-being also affects social structure, policy and governance state, which in their turn result in over-use of resources (direct drivers), causing desertification and land degradation.

## Recommendations

The OSCE and NATO could commission a team of experts to provide a robust, though user-friendly, definition of environmental security. This needs to be supported by description of actual cases in which desertification has been shown unequivocally as a driver of security loss.

The priority for investments by NATO and OSCE in measures that address desertification risks should be directed to southern Mediterranean countries, namely

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most of the Mediterranean Dialogue (NATO) and Mediterranean Partners for Co-operation (OSCE) countries.

NATO and OSCE could commission a small team of experts charged with exploring and harmonising different approaches, including the "Conceptual Framework of the Millennium Ecosystem Assessment", that should come up with a robust yet friendly definition of the relevant terms.

The OSCE and NATO should carry out an independent survey of the current state and current trends, as a basis for developing scenarios for the drylands of southern Mediterranean countries in the coming 25 years. Thus, assessment of current state is of immediate priority, constructing scenarios is the task for the medium-range time-frame, and deriving conclusions as to the effective interventions of NATO and OSCE for the long term time-frame. (Participants concluded that it is not advisable for NATO and OSCE to intervene right away but rather invest first in a situation assessment).

The OSCE and NATO could promote studies in the southern Mediterranean countries that elucidate the role of biodiversity to avert desertification and water scarcity, studies whose results will serve as basis for planning measures for conservation of the biodiversity components relevant to reducing desertification and water scarcity risks.

The OSCE and NATO could assess the state and trends of population growth rates in the rural sectors of the Mediterranean countries, with regard to the growth rates of their populations. This action will enable OSCE and NATO to prescribe action for averting security risk deriving from expected desertification, driven by population growth.

# WG II – LOSS OF LIVELIHOODS AND INCREASED MIGRATION

**Facilitators: Dr. Tamer Afifi, Dr. David Mouat, and Dr. José L. Rubio**
**Rapporteur: Philip Reuchlin**

After initial presentations on a European Commission funded research project on global environmental migration[1] in 24 countries as well as some introduction into scenario development and alternative futures, participants discussed some of the issues related to migration.

Migration is often not perceived to be caused by environmental reasons, not even by the migrants themselves. Indeed academically, the causal linkage is not fully established yet and should not be overstated. What is needed in this respect is more research on very specific case studies in the Mediterranean region, but also in sub Saharan Africa, since the southern Mediterranean countries are increasingly becoming transit countries.

Outward migration is in fact a security issue, in the sense that one looses a lot of local knowledge of the land, and this loss is irreversible. It puts pressures on legal migration channels. However, it should also be noted that migration can have a very positive impact on destination and origin countries. This issue is the subject of a conference to be held in Rabat on 12–13 December 2007.

## Recommendations

The OSCE and NATO undertake pilot projects to increase and improve the livelihoods of local people in order to reduce environmental migratory pressure.

The OSCE and NATO could organize a workshop on technology transfer for better water management in the Mediterranean region.

The OSCE and NATO should promote the dialogue on environmental migration as it will most probably grow in importance over the coming years.

[1] See Annex I.

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The ENVSEC initiative, as a partnership between various agencies specialised each in different areas, can be a vehicle for undertaking more detailed environment and security assessments, but there is a need for Mediterranean countries to demand this.

# WG III – LINKAGES BETWEEN COMBATING LAND DEGRADATION, DESERTIFICATION AND CONFLICT PREVENTION

**Facilitators: Mr Boubacar Cisse and Dr. Abdel Gilil**
**Rapporteur: Gabriel Leonte**

After a general introduction of the UNCCD tasks at proposing measures to countries and regions with the aim to curbing natural resources degradation, promoting sustainable development and therefore avoid conflicts and movements of population, participants agreed that conflicts are mainly triggered by the bad management of natural resources, not necessarily by the fact that resources are limited. The good governance of natural resources is a key factor for conflict prevention, combating poverty, insecurity, migratory pressures

Participants addressed the main question on how can the partnership between the UNCCD, NATO and OSCE be enhanced, also having in view the respective mandates of these organizations and what form of partnership should be established and agreed that the UNCCD as the expert organization provides the general framework, and at national and sub-regional levels its action programme can be the basis for cooperation, whereas NATO and OSCE could raise awareness among their members regarding the links between environment and security and may also raise funds for local projects.

There was an agreement that scientific cooperation is important, as well as the development of case studies and pilot projects but the effectiveness of existing mechanisms should be assessed, so that it can be improved.

A number of countries presented some experiences regarding the management of natural resources, such as:

- Green belts to stop desertification and generate economic activities, stabilize population (Algeria)
- Combating desertification and good governance, irrigation, land amelioration, national parks (Morocco)
- Users associations, in particular in the area of water management, involvement of civil society (Tunisia)
- Reforestation (Spain)

Such good experiences could be shared among the countries in the region. International organizations could facilitate this by, among others, supporting the capitalization of experiences.

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## Recommendations

The OSCE and NATO could commission a survey by an interdisciplinary group of experts to explain the links between environmental degradation and security and the actions needed.

Upon demand from countries in the region, an Environmental and Security Assessment in the Mediterranean region could be launched. It will draw from the Environment and Security Initiative (ENVSEC) experiences in other region and would provide a bridge between scientific expertise and political action. The assessments should focus on possible future conflicts regarding natural resources. Possible scenarios should be developed and based on that prioritization should be decided. Mechanisms to avoid future conflicts should be established.

The OSCE, NATO and Blue Plan could contribute to the UNCCD inter-regional cooperation mechanism.[1]

All participants were invited to report on the results of the workshop to their relevant authorities as follow-up action is needed at various levels and any future engagement should be demand driven.

[1] Within the UNCCD context and its 10 years strategic plan, given that Mediterranean countries are part of different "Annexes", an inter-regional cooperation mechanism should be established.

# WG IV – MANAGING WATER SCARCITY

**Facilitators: Prof. Mohamed Badraoui and Mr. Javier Ferrer**
**Rapporteur: Philip Reuchlin**

After a presentation of the institutional setting of the European Water Framework Directive, National and basin management of rivers, and remarks on the definition of water scarcity[1], participants agreed that integrated water resources management is the best way to overcome water scarcity.

Participants recognised that there is a strong linkage between water economy and economy of energy and therefore industry, agriculture, and urbanizations are competing for water usage, so there is a need for decision making in a quantitative manner in order to be able to allocate water quantity, in order to evaluate cost/benefits.

It was stated that water data is a national security issue (especially in the case of scarcity), therefore sharing these data is difficult, but it would be beneficial for all stakeholders, including civil society and local communities.

There is a need to use jointly conventional measures (like mobilisation in reservoirs/dams[2]) and non conventional measures (like desalination or re-use of treated water) and to increase water usage efficiency and conservation.

There are many networks and initiatives in the area of water management in the Mediterranean region (Mediterranean Network of Basin Organisations, Mediterranean Strategy for Sustainable Development, Medias France, Arab Council of Water, etc.) but there is insufficient coordination among them.

The level of integration of water resources management (watershed, water basins, country, and region) to take into consideration, should be specified.

It was stated also that all Mediterranean countries are exporters of virtual water (exporting water as through agricultural products), except for France.

[1] See Annex I.

[2] In some countries there is lack of storage capacity.

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## Recommendations

The OSCE and NATO could engage in a mechanism of protection and prevention of destruction of transboundary aquifers. A workshop on this issue is recommended.

The OSCE can assist in promoting public participation in environmental issues and decision making in water issues (Aarhus convention).

The OSCE and NATO could foster dialogue on the possible creation of the MENA network of water experts.

The OSCE and NATO should further explore their involvement in:

- Preparing a compilation of best practices of integrated water resources management and water conservation around the Mediterranean basin
- Stimulating innovative ways to provide water and manage water resources, technological transfer, ideas to increase efficiency
- Improve co-ordination among the many different actors who are working on this issue
- Establish a regional monitoring system, based on data exchange and research[3]

[3] Being discussed in Slovenia at a meeting of general directors of water.

# Annex I

## Introductory Remarks to the Working Group IV: Managing Water Scarcity

**Prof. Mohamed Badraoui**

Defined as the annual availability of less than 1.000 $m^3$ of water per person, water scarcity already affects 40% of the world population. This proportion will increase to 66% by 2025 as a result of population growth, climate change and water pollution.

According to the latest report from the United Nations Intergovernmental Panel on Climate Change (IPCC), global warming is likely to have a number of adverse effects on human and natural systems. The main effects are listed below:

- Increased frequency and intensity of droughts
- Increased snowmelts
- Rising sea levels
- Flooding
- Land degradation (desertification)
- Declines in food production
- Increased disease
- More frequent extreme weather
- Loss of biodiversity

Water scarcity is partly due to the uneven geographic distribution of water resources. The Mediterranean region, the sub-Saharan countries and the Middle East are the most affected areas. In these parts of the world, water use is expected to increase with population growth and the demand for water may double by 2050. In these contexts, steps must be taken to improve the way water is managed (Fig.1).

In fact, according to FAO, water withdrawal by the agricultural sector exceeds 80% in the most affected regions by water scarcity.

It is demonstrated by many organisations that the adaptive capacity to water scarcity and climate change relates closely to the society's "level of wealth, education, institutional strength, and access to technology". The combination of high exposure and low adaptive capacity occurs most commonly in south Mediterranean countries, making them highly vulnerable to climate change.

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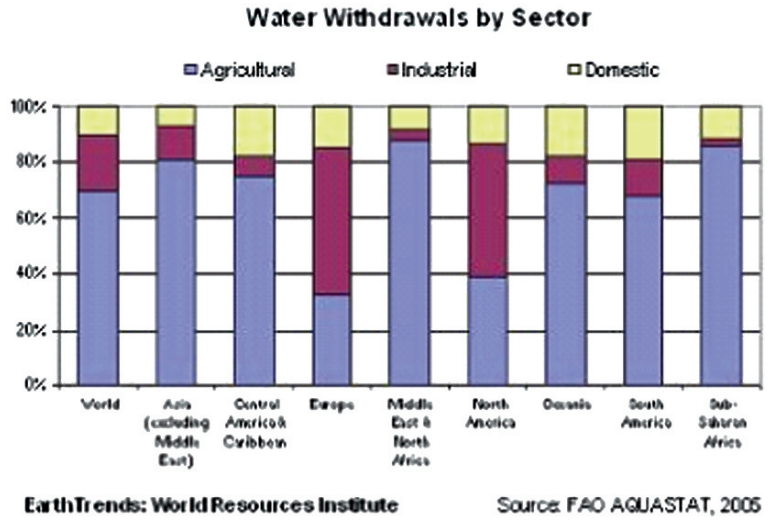


**Fig. 1** Water withdrawals by sector

Selected solutions could be proposed for the most affected countries to improve their adaptive capacity, such as:

- Technological changes to increase water-use efficiency and agricultural intensity
- Scaling-up of infrastructure
- Adoption of sustainable water management practices
- Strengthening of public and private partnerships
- Sharing of both responsibility for water management and its economic and social benefits

In addition, some paradigm shifts should be performed in order to overcome water scarcity. The main shifts concern:

- Demand driven management vs. mobilisation
- Water use efficiency: localized and pressurized irrigation systems instead of surface and flood irrigation
- Integrated water management: new water governance
- Integrated Watershed Management: soil and water conservation and livelihood improvement in upstream of the river basins
- Desalination of sea water

Would desalination be the solution to water scarcity?

Despite technological improvements, desalinated water cost still high compared to the production of drinking water from typical sources. The price varies widely depending on: the salinity of the input water, the energy requirements of the process, the quality of the final waste product, and the distance that the freshwater must be transported. The price will likely decrease with future research and desalination will certainly continue to play an important role in water scarce countries with large coastal populations.

# Annex II

## Egyptian Water and Soil: A Cause for Migration and Security Threats?

**Dr. Tamer Afifi**

### Introduction

The total area of the Arab Republic of Egypt is about 1 million $km^2$, most of which is under arid and hyper-arid climatic conditions, and of which a small portion representing only 3% is agriculturally productive. The six main agro-ecological zones in Egypt are the Nile Valley including the fertile alluvial land of Middle and Upper Egypt, where the main source of irrigation water is the Nile River. Agriculture production of Egypt is mainly concentrated in this zone in addition to the Delta.

1. The Nile Delta region, where the main source of irrigation water is the Nile River as well. Together with the Nile Valley, the agriculture production in this zone consists of about 6.6 million acres. Most of the soil in both areas is recent Nile alluvium.
2. The reclaimed desert areas in the fringes of the Nile Valley, where the only source of irrigation is the ground water.
3. North Coastal zone: including the coastal area starting from North-Western coast moving eastwards to North coastal area of Sinai Peninsula, where there are no reliable figures are available neither on ground water quantity and usage.
4. The Inland Sinai and the Eastern Desert, where the main source for irrigation is the ground water.
5. The Western Desert including oases and southern remote areas, where the groundwater is mainly extracted from the Nubian Sandstone and carbonate aquifers.

Although the Nile River streams through the Egyptian land, water is regarded as a scarce natural resource, due to the rapidly growing population in Egypt, the latter's limited quota of the Nile Water and the wide desert lands where the main drinking and irrigation water resource is the underground water. Furthermore, the Egyptian land suffers from different variations of degradation along the country, depending on the region and the inhabitants.

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This paper addresses the question whether water shortage and land degradation can have an impact on migration within and from Egypt and whether this could have implications on security, especially that Egypt is part of the Mediterranean region that is one of the most vulnerable areas in terms of environment and security linkages.

The paper starts with a literature review on environmental migration, moving on to demonstrating some details on general migration in Egypt. Then the paper sheds a light on water shortage and land degradation, moving on to the outcomes of the field work run in Egypt, and attempting to link the two aforesaid environmental problems to migration patterns and hence eventual security problems. The paper concludes that environmental migration exists in Egypt, but that it is not a sufficient factor for taking the decision of migration, since usually there are other 'amplifying' social and economic factors that influence such a decision or at least seem for the migrants to be the real reasons for their migration.

## What others wrote about 'environmental migration'?

In this section, the paper attempts to shed a light on the literature that tackled the topic 'environmental migration' and how the issue is looked at from different points of view, according to the different authors and/or organizations.

In a report released by the UN Environment Program (UNEP), El-Hinnawi (1985) defined the environmental migrants as "those people who have been forced to leave their traditional habitat, temporarily or permanently, because of a marked environmental disruption … that jeopardized their existence and/or seriously affected the quality of their life".

Numbers and figures about environmental migrants worldwide differ depending on the definitions and hypotheses. UNEP former head, Klaus Töpfer, talks of 22–24 million environmental migrants (Biermann, 2001), whereas Myers (2005) reports 'at least' 25 millions in 1995 (latest date for a comprehensive assessment), especially in the African Southern Sahara, China, Central America and South Asia. Myers even expects the number to reach around 50 millions by the year 2010. Myers compares these 25 million environmental refugees to 27 million 'traditional' refugees (people fleeing political oppression, religious persecution and ethnic troubles).

On the other hand, many other international documents, such as the *Declaration on Environment and Development* of the 1992 Earth Summit in Rio de Janeiro, do not mention a single word about 'Environmental migrants'. Agenda 21 of the Summit refers to the word only one time in the frame of the sub-program for droughts and desertification. The number of the environmental migrants in the 'law of nations' is an unknown figure as well (Biermann, 2001).

The *Geneva Refugee Convention* of 1951 does not identify environmental degradation as a cause for flight and therefore does not offer environmental migrants protection, as long as they do not fulfill the criteria of the Convention, i.e. as long as they are not classified as people leaving their habitat due to their race,

religion, nationality, membership of a social grouping and/or political opinion. By this definition, the Convention excludes intra-country migrants among which environmental migrants occur more often as compared to cross-border migration (UNHCR, 2006).

Regional agreements for protecting refugees in Africa and Latin America are more detailed and comprehensive than the Geneva Convention and include further categories of refugees. However, they still do not identify environmental degradation as a flight cause.

The 1949 established United Nations High Commissioner for Refugees (UNHCR) considers the problem of 'environmental migrants' as a minor issue, since environmentally vulnerable people usually enjoy the protection of their governments, and can therefore not be defined as 'refugees' in the strict sense of the refugee right.

Although UNHCR established an 'environment fund' and introduced an 'environment coordinator' in the early 1990s, the rationale was to prevent the ecological consequences of mass flight and not vice versa. Therefore, many authors avoid in principle using the term 'Environmental refugees' and rather talk of 'Environmental migrants', in order not to weaken the status of the political refugees, who might be in a more urgent and severe position.

Myers (1997) talks of hundreds of millions of environmental migrants by arguing that people simply cannot find an alternative for protection anywhere else, no matter how their attempts to escape to new places would be risky.[1] However, Castles (2002), also supporting Black (2001), disagrees on such 'horror scenarios'. He claims that migration is not the main strategy of such people; when their livelihoods worsen, they tend to move from one place to the other within the same region. They rarely cross the country borders. For example, the sea level rise in Bangladesh was not a sudden phenomenon. Therefore, he believes that some parts will be protected by dams and the others will have to be abandoned, but the majority of the people will stay in the country, and only the minority will leave for India.

According to Traufetter (2007), a focal point is the reaction of different governments to natural catastrophes. After the earthquake in Kobe, Japan, most of the 300,000 displaced people returned back a few months after the incidence, whereas it took years for people to return after the Pinatubo Volcano in the Philippines. In addition to the loss of livelihoods and income opportunities, a second reason for 'environmental out-migration' is the fear that the impacted area may experience more natural disasters in the near future. While some people do not return after a disaster, the fear of disasters does not prevent some migrants from returning to their homes (Mileti, 1999).

The reaction of governments does not only depend on the financial resources available. Institutional management, including control of corruption, risk communication among different demographic groups, and aid assistance policies affect out-migration after a natural hazard event. The widely-discussed performance of the U.S. evacuation effort during and after Hurricane Katrina may have contributed

[1] Myers comes up with similar idea in Myers (2005).

to specific sections of the population not being able to resettle in their homes in the post-hurricane period (Renaud et al., 2007). For example, public housing in which many welfare-dependent African American families lived were deemed unfit for dwelling, yet the inhabitants were not offered local housing alternatives following the hurricane and moved elsewhere. Disasters can also attract inward migration, as in the case of the tornado of 2004 in North-central Bangladesh. Paul (2005) found that emergency aid can compensate in monetary terms for damage caused by disasters.

Faist (2007) warns of 'too sharp' expressions concerning environmental migration. He agrees that climate change is a considerable problem, believes however, that people leave their habitats due to ethnic, economic and political problems, and that climate merely serves as a catalyst. He also expects that most of the affected people are the poor, and therefore, they do not have the means to migrate across regions, not to mention from one country to the other.

In order to transform this debate into a quantitative analysis based on real data and numbers, we attempt to find out whether there is a direct impact of environmental degradation in one country on the migration flow out of this country by running a gravity regression model as will be shown in the following section.

In the following, two key environmental problems in Egypt, namely water shortage and land degradation are demonstrated. Later on, the link between these two factors and migration in Egypt is assessed.

## A General Overview of Migration in Egypt

Since the paper is concerned with migration induced by environmental problems, particularly water shortage and land degradation, it focuses on emigration rather than immigration. Unfortunately, there is a big lack of data about internal migration in Egypt. The reason for that could be the fact that many Egyptians move from one region/city to the other within one day, due to work obligations, and therefore, it is hard to calculate the exact number of people who moved and really settled in the different cities. Moreover, it is easier to monitor the numbers of people who crossed the country borders, since all the movements are documented in contrast to the internal movements.

The Egyptian constitution considers emigration as a basic right for the Egyptian citizens. This was confirmed by Article 52 of the permanent constitution released in the year 1971 and stating that: "… The Egyptian citizens are entitled to emigrate permanently or temporarily …"

To apply the constitution, the Law 111 for Egyptian emigration abroad was released in the year 1983. Article 1 of the Law 111 gives the right of the Egyptian citizens to emigrate individually or in groups, permanently or temporarily, reserving their right to keep the Egyptian nationality, and in this case they do not lose their constitutional or legal rights.

In order to encourage the Egyptian emigrants abroad to keep the ties with their mother country, Article 15 of Law 111 gives them the privileges of carrying other nationalities, receiving social assistance and pensions, having an Egyptian passport re-issued abroad, exempting their investments in Egypt from certain taxes and duties and re-occupying one's job 2 years after resignation from the government sector (Egyptian Ministry of Manpower and Migration).

The majority of Egyptian labour migrants are expected to return home eventually, but thousands leave their country each year with the intention of permanently resettling in various Arab countries, Europe, or North America. These emigrants tended to be highly educated professionals, mostly doctors, engineers, and teachers. Iraq was the Arab country most likely to accept skilled Egyptians as permanent residents. Besides the Arab countries, the United States was a preferred destination.

According to the official estimates of the Central Agency for Public Mobilization and Statistics (CAPMAS), the total number of Egyptian temporary migrant labourers (in Arab countries) is about 1,9 million (CAPMAS, 2001). The top five of destination countries are: Saudi Arabia (48,3%), Libya (17,4%), Jordan (11,9%), Kuwait (10%) and UAE (United Arab Emirates, 5%) (Table 1).

From the beginning of the 1960s, political, economic, and social developments led Egyptians to migrate permanently to the USA and European countries. According to the estimates of CAPMAS, the total number of permanent Egyptian migrants in non-Arab countries is slightly more than 0,8 million (824.000) (Table 2). About 80% of them are concentrated in five countries: USA (318.000 or 38,6%), Canada (110.000 or 13.3%), Italy (90.000), Australia (70.000), and Greece (60.000). The other 20% are mainly in Western Europe countries, such as Holland, France, England, Germany, Switzerland, Austria, and Spain (CAPMAS 2000).

The statistics given by CAPMAS are just estimates which are drawn from the reports of Egyptian embassies abroad, records of cross-border flows from the Ministry of Interior, emigration permits from the Ministry of Manpower, and some other sources. The receiving countries make different estimates than CAPMAS.

**Table 1** Temporary Egyptian migrants by country of destination (CAMPUS, 2001)

| Receiving Country | Number of Migrants | Percentage |
|---|---|---|
| Saudi Arabia | 923.600 | 48,3 |
| Libya | 332.600 | 17,4 |
| Jordan | 226.850 | 11,9 |
| Kuwait | 190.550 | 10,0 |
| UAE | 95.000 | 5,0 |
| Iraq | 65.629 | 3,4 |
| Qatar | 25.000 | 1,3 |
| Yemen | 22.000 | 1,2 |
| Oman | 15.000 | 0,8 |
| Lebanon | 12.500 | 0,7 |
| Bahrain | 4.000 | 0,2 |
| Total | 1,912,729 | 100.0 |

**Table 2** Permanent Egyptian migrants by country of destination (CAMPUS, 2000 – 'The United Evaluation 2000')

| Country of Destination | Number in Thousands | Percentage |
|---|---|---|
| USA | 318 | 38,6 |
| Canada | 110 | 13,3 |
| Italy | 90 | 10,9 |
| Australia | 70 | 8,5 |
| Greece | 60 | 7,3 |
| Holland | 40 | 4,9 |
| France | 36 | 4,4 |
| England | 35 | 4,2 |
| Germany | 25 | 3,0 |
| Switzerland | 14 | 1,7 |
| Austria | 14 | 1,7 |
| Spain | 12 | 1,5 |
| Total | 824 | 100.0 |

For example, the Italian government estimates there are around 35.000 Egyptians in Italy whereas CAPMAS gives a figure of 90.000.

Logically, there are no concrete or reliable figures about illegal migration. Nevertheless, there are tens – if not hundreds – of Egyptians who were caught in the past years after illegally attempting to cross the Mediterranean to reach Italy, Malta and Spain. The source of information is usually the newspapers, but there are no real statistics that cover the phenomenon. When arrested, most of them mention poverty and unemployment as main reasons. None of them – to the knowledge of the author – mentions political or environmental reasons.

This general overview gives an idea about the general trends and figures. However, it does not classify the migrants according to the reason(s) for migration, simply due to the lack of data and interest in the topic 'environmental migration'. In the following, the environmental problem in Egypt, particularly water shortage and land degradation are demonstrated. Later the paper attempts to detect the link between these environmental factors and migration in Egypt.

## Water Shortage in Egypt

The 'Nile water' as a political issue in Egypt issue backs at least to the 19th century. With the fall of the Arabic Empire in the 1980s of the same century, the Egyptian Project for the Political and Water Union of the Nile Basin Region had an end as well, and the British occupation in Egypt took place starting from the year 1882, where the British Empire had not only Egypt but also Sudan, Uganda, Kenya and

British Somalia[2] under control. Most importantly in this context was the British control over the waters of these countries. In the Egyptian case, Great Britain (GB) gave a special priority to the water issue by hiring a number of British experts and consultants in the Egyptian Ministries of Agriculture and Irrigation, especially that the population was increasing and that the cultivated lands were extended.

In the year 1929 an agreement was signed between Egypt on one hand and GB on behalf of Sudan, Uganda and Kenya, on the other, where the quota of each country's water consumption was determined. A similar agreement was signed in the year 1939 where the terms were some details were changed, followed by another Agreement signed by Egypt and GB in the year 1949 concerning the construction of small dams and water falls, in order to generate power. The Egyptian Revolution of 1952 triggered the importance of the Egyptian water as a 'national' asset. This lead to the High Dam Agreement signed with Sudan in the year 1959 to determine both countries' yearly shares of water consumption. In the year 1978 Egypt commenced an Official Plan for Water Resources which was extended by a so called Master Plan that was initiated by the Egyptian Ministry for Irrigation and Water Resources in the year 1981 to save the water for the future generations and to use the most rational irrigation methods (Ouda, 1999). Egypt is planning the Toshka Canal as well, which is supposed to pump part of the Nile water into the Western Desert, a sensitive topic for some other Nile Basin countries (Stroh, 2004).

In spite of all these agreements and plans, and as much as the Nile River has been a generous water resource for Egypt, the Egyptians are suffering from water shortage, due to the limited Egyptian quota from the Nile – according to its agreement with the ten Nile Basin countries – as well as the continuous increase in population at high rates. Taking the expression 'water shortage' more broadly, it would encompass the access to clean water that is suitable for drinking and irrigation; unfortunately, Egypt has been notorious for water pollution, since the Nile and its canals have been subject to industry, agricultural and individual wastes for the past decades. Poor water management due to inefficiency of the traditional gravity irrigation system, inadequate maintenance of irrigation and drainage networks and over abstraction of ground water, especially in the newly reclaimed desert areas, are all factors that magnified the problem. Another natural factor that diminishes the available fresh water is the water salinity, a phenomenon that largely exists in the newly reclaimed desert lands that rely on ground water.

## Land Degradation in Egypt

There are different causes for land degradation in Egypt; a number of irrigated farmlands in the Nile Valley and Delta as well as the newly reclaimed desert lands are suffering from soil salinity. This has reduced the productivity and increased in the duration required for reaching their acceptable productivity level and eventually to

[2] The rest of Somalia was occupied by Italy.

their ideal productivity, which in turn caused the loss of effort, money and time. In order to compensate for the low productivity caused by soil salinity, the usage of organic fertilizers, the adoption of irrational agricultural management techniques and excess irrigation was exaggerated, which enhanced the problem and created a vicious circle.

With the beginning of the 1970s, the soil pollution impact started due to the excessive use of chemical fertilizers, namely nitrogenous, due to the farmers' wrong impressions after the construction of the Aswan High Dam (Science Research Academy, 1971–1975). Moreover, many nutrient elements of the Nile Valley and Delta soil were depleted and defected by the extensive and frequent cropping, unsustainable irrigation water management and improper agricultural practices. The construction of the dam itself decreased the annual additions of the fertile sediments to the soils that consequently lost lots of their content of organic matter, total nitrogen and other nutritive elements. Excessive use of chemical fertilizers persisted due to agriculture production intensification and attempts to reach the highest production possible/unit area. Soil pollution has also increased due to the irrationalized use of different pesticides. In addition, wastewater and industrial drainage leakage into watercourses has exacerbated the problem, especially that there was a very poor implementation of pollution control regulations.

Wind erosion is a major cause of land degradation in Egypt, since it exists in the Western and Eastern deserts as well as inland Sinai and the coastal zones. It is mainly caused by the arid climate. The most vulnerable to wind erosion and deposition are sand dunes and other sand forms in the coastal and inland deserts. Since wind erosion clearly leads to the drifting of surface soil layers, the agricultural development, rural and urban settlements, road traffic and public health are negatively affected.

Water erosion occurs in the Northern coastal zone of Egypt where intense rainstorms cause excessive water surpluses leading in turn to enormous soil loss. Nevertheless, the same lands – since these lands fully rely on pluvial irrigation – are very often exposed to periods of dryness, lower rain compared to their annual average and bad distribution of rains during rainy seasons.

Another factor that does not directly lead to land degradation but rather lowers the chances of planting and cropping in Egypt is urban encroachment. It occurred in Egypt due to the expansion of cities and villages and the establishment of industrial facilities and infrastructure. Additionally, soil surface scrapping for manufacturing red bricks was a phenomenon that had a negative impact on fertile lands.

In concrete numbers, around 30% of the irrigated farmlands in Egypt suffer from salinity. Of the Northern cultivated land and both Middle and Southern Delta regions, 60% and 20%, respectively, are considered salt-affected soils. Wind erosion affects about 90% of the total country area. The average rate of soil loss due wind erosion in the Western Desert Oases has been estimated varies from 4,5 to 66,9 ton/ha/year (Egyptian National Action Program to Combat Desertification, 2002). The area influenced by the active encroachment of sand and sand dunes is estimated to be 1,6 million ha. Land productivity has diminished by about 25% compared to its original productivity (Regional Report on Desertification in the Arab World, 2000).

The annual water erosion rate has been estimated between 0,8 and 5,3 ton/ha/year (Egyptian National Action Program to Combat Desertification, 2005). Soil scrapping for manufacturing red bricks has been nearly overcome as a result of the legislation issued in 1983 and amended in 1985 (Egyptian National Action Program to Combat Desertification, 2002). Urban encroachments started during the 1950s and caused the loss of 15.000 ha annually (Institute of Lands, Water and Environment, 2000). A military order has then been issued to stop and eliminate such encroachments in 1996, significantly limiting such phenomenon, but probably, after it was too late. It is also found that the losses of plant nutrients; nitrogen, phosphorus and potassium are linearly proportional to soil loss (Egyptian National Action Program to Combat Desertification, 2005).

From this brief overview about water shortage and land degradation in Egypt one can sense the serious environmental problems that Egypt is facing, especially that these problems are directly related to the livelihoods of the people. The question would be: Could these environmental factors lead to displacement/migration in Egypt? Who would migrate and where would they go? Would this have implications on security issues? This is what this paper attempts to detect through a field work that was run in different areas in Egypt and where a questionnaire was designed for migrants as well as non-migrants who moved from one place to the other within the Egyptian boundaries. The aim was to know from the migrants whether/to what extent water shortage and land degradation influenced their migration decisions and knowing from the non-migrants whether they would leave their lands due to these two environmental problems.

## Questionnaire and Geographic Coverage of Field Work

The 30 migrants[3] that were interviewed were mainly in the centre of the Nile Delta, the Nile Valley (South and North), Eastern and Western Nile Delta, newly reclaimed desert lands and slums of Old Cairo. The questionnaire was semi-structured and included other non-environmental factors that could have led to the migration of interviewees, such as poverty and social problems. The selection of the interviewees was random, due to the limited awareness of the issue and the difficulties of accessing the target groups in an organized way.

The target groups were people who left the Nile Valley and Delta for slums of Old Cairo, people who left the Oasis and moved to Cairo, people who moved from one area to the other within the Nile Valley and Delta, people who moved from fertile lands to the newly reclaimed desert lands, and people who stayed in the Nile Valley and Delta. Due to the relatively limited number of interviewees, the author did not only rely on the information about their personal experiences but also on their stories about their parents, relatives and friends.

[3] Due to time and financial constraints, the number of questionnaires was not big enough to run an econometric model.

## Field Results

Most of the people who left the relatively fertile lands in the Nile Valley and Delta and moved to Cairo were mainly induced by unemployment and poverty problems. However, in most cases land degradation and water shortage were actually the causes for these problems. Even if the migrants would not mention that explicitly, one could indicate it from their answers. The interviewees who mentioned that they left their Oasis in the Western Desert mainly to seek better livelihoods and standards of living in Cairo referred implicitly to the sand dunes that hindered them from planting and shepherding properly in their original home areas. Unfortunately, the migrants who left for the slum of Old Cairo were shocked by the fact that they were running harder lives that they had expected from Cairo. All of them were hoping to find the means to move to richer districts in Cairo, since at the time of the interviews they were suffering from environmental problems as well, such as low access to clean water and other sanitary problems.

People who moved from one area to the other within the Nile Valley and the centre of the Delta had different reasons; some had moved with their parents who worked as peasants or farmers in the early 1980s of the last century when the owners of the fertile lands decided to use the latter in construction buildings or soil surface scrapping for manufacturing red bricks. In these cases, their parents were forced to be displaced from the lands, since they neither owned them, nor were there signed contracts that would preserve their right to stay or to be compensated. Others moved within the Valley and the Delta, since they were unemployed, but this group would not dare completely shift to the completely different 'life style' of Cairo. Therefore, they moved to similar areas, but where they could find better livelihoods.

Among the latter group, some left their original towns in the Nile Valley and the centre of the Delta for Eastern and Western Delta, where the Egyptian government has initiated two major projects close to the Bahr El-Bakar Canal and the Noubaria Canal, respectively. The main reasons why they moved were again poverty and unemployment. Nevertheless, most of the interviewees and their friends who currently live there were seriously thinking of going back to their home towns or moving to third areas, since they are suffering from environmental problems such as poor access to clean water. For example, Cairo uses the Bahr-El-Bakar Canal as an outlet for its sewage. Moreover, they claim that the infrastructure and housing in these areas are insufficient for a decent life. In addition, the schools are mainly primary rather than secondary.

Another interviewed group were the people who moved to the newly reclaimed desert lands, since they were unemployed in their home towns and were promised to work as peasants in these lands. However, most of them were suffering from soil and water salinity problems. Some of them even already moved to different areas within the newly reclaimed desert lands mainly because the owners of the lands decided to sell them when they did not have enough financial means to dig for new ground water. No one of these peasants could afford to own a land, and therefore, they were quite mobile and were able to easily move, especially that working on these lands was in most cases the only financial resource for them. Some owners

of these lands did not really make their living from the crops planted there; most of them originally lived in Cairo and preferred to spend the rest of their lives away from the air pollution there. Hence, they built their farms in the newly reclaimed desert lands and relied financially on their savings that they gained when they used to work in the capital. When the salinity problem occurs in the ground water, they would not have a problem in digging for new ground water, since they are well off.

Last but not least, a group of interviewees in the Nile Valley and Delta were suffering from water shortage and land degradation. However, since they own the land and feel emotionally attached to it, they would not leave it, even if the pull factors in the city or elsewhere were very strong. As long as they can afford their living, even if it worsened in the past years, they would stay.

None of the interviewees completely left the country. Nonetheless, when some of them mentioned their relatives/friends who crossed to borders, mainly to other Arab rich countries, they mentioned poverty and unemployment as the main reasons, even though these two factors may indirectly be caused by water shortage and land degradation.

## Implications on Security

To date, there is no evidence that migration flows within or from Egypt in relation with environment have affected the security situation in the country or abroad. However, the illegal migrants mentioned in section "A General Overview of Migration in Egypt" and who attempt to cross the Mediterranean as well as other Egyptian borders, seeking better livelihood, and whose migration decisions are likely influenced by environmental problems, might induce security problems through two channels; firstly, if they would succeed in leaving the country, they would illegally reside in the countries of destination, at least for a given period of time. In order to survive, they would possibly join illegal activities, such as drug smuggling, which could lead to security threats in the host countries. Secondly, if they would fail to leave the country, they would very likely be a burden on the society, in the sense that they would stay unemployed, since in first place they were planning to leave the country for livelihoods that they missed in their home country. This could also have negative implications on the security, since the severer the poverty and the more the unemployment, the more one would expect disorders to occur.

## Conclusions

Egypt is generally an outward oriented country, in the sense that the government allows for emigration, as long as it is legal and the reasons are acceptable. On the other hand, environmental problems, such as water shortage and land degradation are certainly important challenges facing the Egyptians, given the rapid

population growth. Whether there is a relationship between Egyptian environment and migration, this is what the paper attempts to assess.

It is hard to draw a direct relationship between environment and migration, especially if one attempts to find a precise impact of environmental problems, such as land degradation and water shortage on the migration flows. There are other financial, social and cultural factors that influence a decision to migrate. In addition, both factors do not occur suddenly; it takes decades till one can sense them, which makes the task of finding the link more challenging.

From the results of the field work in Egypt it can be concluded that people in Egypt would be moving/migrating from one place to the other within the country in case of water shortage and/or land degradation only under certain conditions; they would only do that, if they are not land owners, if they can socially and financially afford leaving their place of origin, and/or if they are forced to be displaced by the government or the owners of the land. The water shortage and land degradation factors in Egypt are definitely not strong enough to make people decide to leave the entire country. This would need additional pull factors in the receiving countries such as a big financial return and/or higher living standards on one hand, and/or additional push factors in Egypt, such as poverty or unemployment, on the other. In general, as long as the people are not facing a sudden natural disaster, such as earthquakes or floods, they would not be willing to leave their home.

In the cases were people are willing – and can afford – to leave, especially in an illegal framework, the security question must be raised, since one should expect from people who are desperately seeking better livelihoods and simultaneously facing new cultures to act differently from people whose lives are secure. The same would apply to people who attempted to migrate but were left behind.

## References

Biermann, F. (2001) Umweltflüchtlinge, Ursachen und Lösungsansätze, Aus Politik und Zeitgeschichte, B 12/2001.

Black, R. (2001) "Environmental Refugees: Myth or Reality?" UNHCR Working Papers (34): 1–19.

Bogardi, J.J. and F. Renaud (2006) Migration Dynamics Generated by Environmental Problems. Paper presented at the 2nd International Symposium on desertification and Migrations, Almeria, 25–27 October 2006.

Castles, S. (2001) Environmental Change and Forced Migration, Preparing for Peace Initiative: the Website of the Westmorland General Meeting. http://www.preparingforpeace.org/book1.htm.

Castles, S. (2002) Environmental change and forced migration: making sense of the debate. In: New Issues in Refugee Research. Working Paper No.70. United Nations High Commissioner for Refugees, Geneva.

Egyptian Ministry of Manpower and Migration (http://www.emigration.gov.eg/).

Egyptian National Action Program to Combat Desertification (2002) Arab Republic of Egypt Ministry of Agriculture and Land Reclamation, Desert Research Centre (DRC), Cairo.

Egyptian National Action Program to Combat Desertification (2005) Arab Republic of Egypt Ministry of Agriculture and Land Reclamation, Desert Research Centre (DRC), Cairo.

El-Hinnawi, E. (1985) Environmental Refugees, United Nations Environment Programme, Nairobi.

Faist, T. (2007) Umweltflüchtlinge, Interview on German Radio (Deutschlandradio). http://www.comcad-bielefeld.de/cgi-bin/pagemaker.pl?name=aktuelles, 3 April 2007.

Global Migrant Origin Database, Development Research Centre on Migration, Globalization and Poverty. http://www.migrationdrc.org/research/typesofmigration/global_migrant_origin_database.htm.

Grote, U., S. Engel, and B. Schraven (2006) Migration due to the tsunami in Sri Lanka – Analyzing vulnerability and migration at the household level, ZEF-Discussion Paper on Development Policy No. 106, Centre for Development Research (ZEF), Bonn, April 2006.

Institute of Lands, Water and Environment (2000) Land Degradation in the Nile Valley and Delta, Agriculture Research Center, Giza.

Jakobeit, C. and C. Methmann (2007) Klimaflüchtlinge, Eine Studie im Auftrag von Greenpeace, Fakultät Wirtschafts–und Sozialwissenschaften, Universität Hamburg.

Mileti, D.S. (1999) Disasters by Design: A Reassessment of Natural Hazards in the United States. Joseph Henry Press, Tokyo.

Myers, N. (1997) "Environmental Refugees," *Population and Environment* 19(2): 167–182.

Myers, N. (2005) Environmental Refugees: An Emergent Security Issue, 13th Economic Forum, Prague, 23–27 May 2005.

Ouda, Abdel Malak (1999) 'Egyptian Policy and the Nile Water in the 20th Century,' Centre for Political and Strategic Studies, Ahram News Agency, Cairo.

Paul, B. (2005) Evidence against disaster-induced migration: the 2004 tornado in north-central Bangladesh Disastors 29 (4), 370–385.

Regional Report on Desertification in the Arab World (2000) Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD), Damascus.

Renaud, F., J.J. Bogardi, O. Dun, and K. Warner (2007) Control, Adapt or Flee: How to Face Environmental Migration? Intersections No. 5/2007, United Nations University, Institute for Environment and Human Security.

Science Research Academy (1971–1975) Impact of reduced Nile alluvial, Cairo.

Stroh, K. (2004) 'Konflikt und Kooperation um Wasser: Eine Fallstudie über den Nil,' Arbeitspapier zu Problemen der Internationalen Politik und der Entwicklungsländerforschung, Geschwister-Scholl-Institut für Politische Wissenschaft der Ludwig-Maximilians-Universität München.

Traufetter, G. (2007) Legende vom Exodus, der Spiegel, 7 April 2007.

United Nations High Commissioner for Refugees (UNHCR) (2006) Convention and Protocol Relating to the Status of Refugees: Text of the 1951 Convention Relating to the Status of Refugees, Text of the 1967 Protocol Relating to the Status of Refugees, and Resolution 2198 (XXI) adopted by the United Nations General Assembly, UNHCR, Geneva. http://www.unhcr.org/protect/PROTECTION/3b66c2aa10.pdf, 4 July 2007.

# Conclusions

**José L. Rubio and Uriel Safriel**

The Mediterranean basin is one of the five global regions characterized by a Mediterranean climate – long dry and hot season, resulting in low and high annual rainfall and evaporation, respectively. This qualifies the areas of a Mediterranean climate as semiarid drylands. Compared with the other global regions of a semiarid Mediterranean climate, the Mediterranean basin has been impacted by the most prolonged and intense human pressure. This has resulted in ever increasing overexploitation of land productivity, and a current state of degradation and degradation risk of much of its land and water resources. Furthermore, most countries around the Mediterranean Sea also have within their territories non-Mediterranean climatic regions, with drylands which are also at risk of degradation even though these lands are either dryer (arid drylands) or enjoy better climate than the semiarid Mediterranean areas (dry sub humid drylands).

Given the projections of further and even accelerated population growth, coupled with the detrimental effects on water and soil brought about by trends of a changing climate in the Mediterranean region, the degradation risks in all the Mediterranean regions combined are expected to materialize, resulting in a widespread Mediterranean desertification. The expected expression of this desertification is a failure of the Mediterranean lands to provide the flow of ecosystem services, especially those associated with clean water and food provision, required for making any further development in the Mediterranean basin sustainable. This will detrimentally affect human well-being in the Mediterranean region. Mostly affected will be those Mediterranean countries that are socially and economically weak, hence of low resilience and lacking coping capacity. Therefore the impact of desertification on these countries constitutes a potential threat of destabilising the region.

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The Mediterranean desertification syndrome therefore constitutes a breach of environmental security which, if not addressed in time, will generate land abandonment, rural to urban migration, forced population displacement, social unrest and ethnic conflicts. These may culminate in local and regional political instability with security implications reaching far beyond the Mediterranean region.

Addressing the projected fragile regional environmental security, within Mediterranean actions at three levels are required – knowledge, policy and cooperation. Regarding knowledge, several thrusts of scientific and technological research and their application need to be encouraged.

(a) Whereas much knowledge on the biophysical drivers of Mediterranean desertification exists, the large gap in understanding the social-economic-policy drivers of desertification needs to be bridged by well-focused and targeted multidisciplinary and internationally coordinated joint scientific research.
(b) Better understanding is critically needed, regarding the potential effects of global climate change on the climate, ecological, economic and social systems of the Mediterranean region, with an emphasis on water resources, desertification and its direct (biophysical) and indirect (human-related) drivers.
(c) Development of practices and technologies of early warning systems are required, as well as practices of preparedness for mitigating the effects of extreme events including droughts and woodland fires, expected to increase in frequency and intensity in the Mediterranean region.
(d) Those measures for reducing the risks of desertification, which are also instrumental in mitigating climate change and hence it's potential to further exacerbate desertification, need to be explored, promoted and adopted.
(e) Innovative and imaginative approaches for reducing the impact on land and water resources in spite of increasing population pressure need to be promoted. These may include shifts to alternative livelihoods that capitalise on hitherto untapped environmental advantages of many Mediterranean drylands such as the prevailing winter warmth (e.g. ecotourism, cash-crop agricultural exports), and the abundant sun irradiation (e.g. solar energy technologies).

With regard to policy and in recognition of social and political implications of a challenged environmental security, governments of Mediterranean countries need to streamline their environmental policies into their development programs and include them in their political agendas. This integrated policy approach should strive to promote development which is supported by environmental services that are resilient to climate change and to a prudent increase in individual consumption and population growth. Such policies could secure the sustainability of the development, contributing to social stability and promoting local and regional security.

Regarding cooperation, there exist a need for internationally-coordinated Mediterranean programmes fostering security as a tool for cooperation and crisis prevention. The joint efforts of OSCE and NATO could help bringing together other international organizations of the region for increasing dialogue, reinforcing and implementing shared and joint activities addressing desertification, water scarcity,

climate change and sustainable development. This could include promotion of common methodologies in research, surveying, monitoring and assessment initiatives. These combined, addressing environmental risks to security and fostering stability through co-operation in environmental management, would promote the sustainable use of lands in the Mediterranean region, thus contributing to regional security.

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