

Dangerous Materials: Control, Risk Prevention and Crisis Management

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Series C: Environmental Security

Dangerous Materials: Control, Risk Prevention and Crisis Management

From New Global Threats to New Global Responses: A Picture of Transition

edited by

Alberto Brugnoli

IReR - Lombardy Regional Institute for Research
Milan, Italy



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PREFACE

ADRIANO DE MAIO

IReR President

This publication originated from the workshop on “Control and risk prevention of dangerous materials and crisis management” that took place in Sofia, Bulgaria, in March 2009.

The basic idea is that international scientific cooperation can effectively contribute to security, stability and solidarity among nations, through increased collaboration, networking and capacity-building and supporting democratic growth and economic development in Partner Countries.

We are all facing new needs and threats, deriving from a world changing constantly its social, political and economic dimension and, for this reason, the international dialogue through civil science represents a way forward to commitment to global common issues.

In fact, the Lombardy Regional Institute for Research has developed some international activities aiming at establishing networks of scientists and experts in defined areas and subjects. Through one of these activities, the Institute entered in touch with the *Science for Peace and Security Programme*.

In this framework, we decided to share the experience of Lombardy Region on transportation of dangerous materials (half of their total transport in Italy): research and studies in civil area conducted in Lombardy Region are considered the most innovative in Europe for the results obtained.

Comparison with diverse international experiences is a great opportunity of implementing present results and applying them to different applications (from civil to anti-terrorism) and extending them to countries other than Italy.

Therefore, the pages that follow collect contributions from scientists and experts having a variety of different backgrounds and involving different perspectives: the territorial level, represented by Regional expertises; the National one, represented by different countries’ and Governments’ representatives and the European and International levels through their officers’ perspectives.

We look on this publication as a moment of reflection and knowledge-sharing on risk management of dangerous materials, targeting specific topics of horizontal interest for safety and security issues, with the aim of starting new partnerships enabling a sustainable scientific community.

We therefore hope this is just a beginning, flexible enough to let the reader make a personal reflection and, last but not least, we would like to take the opportunity to acknowledge the *Science for Peace and Security Programme* and the NATO Science Committee for making all this possible, all the participants to the event in Sofia and the authors of these articles for their valued contributions and, last but not least, the Lombardy Foundation for the Environment – FLA for their support.

PREFACE

HRISTO SMOLENOV

CUNG Director

This collaboration between CUNG and IReR originated from the international scientist community, started with the workshop on Control and risk prevention of dangerous materials and crisis management that took place in Sofia, Bulgaria, in March 2009.

We would like to thank The *Science for Peace and Security Programme* of NATO for the opportunity, which gave the possibility to share experiences and expertise, to activate partnerships and to transfer knowledge. Aims that also this publication intends to achieve, in the framework of the international scientific cooperation.

Among the Balkan countries, Bulgaria has always been attentive on the issues of transport and goods, particularly thinking of the borders that frame the territory.

In fact, Bulgaria borders on five other countries: Romania to the north (mostly along the River Danube, an international river considered as a border with the European Union), Serbia and the Republic of Macedonia to the west, and Greece and Turkey to the south. The Black Sea defines the extent of the country to the east.

Concerning the goods, the type of materials that cross the borders are various: strategic raw materials, which are dangerous, explosives, weapons, supplies, radioactive materials and other toxic substances and poisons and trans-frontier garbage, even if it is difficult to find a definition for what garbage is, what it includes, if it is a mixture of several products and this is a problem that Bulgaria faces nowadays.

In this framework, the country continues to work on the improvement of the national legislation and the control and risk preventions measures according to the *acquis Communautaire* (European Union laws and policies), and it has already implemented the international collaborations as such with the Agency of Atomic Energy.

This geography, together with the system of transports, such as airports (five international airports), boats, trucks, railways and so on, pictures a quite variegated territory accompanied by difficulties: lack of necessary equipment and resources, information system and communications, sometimes staff trained appropriately.

Nonetheless at the same time, these “obstacles” to safe and security can be overcome also through the knowledge and this situation stimulates an interesting comparison with the experiences of the Italian and the international scientists gathered at the workshop in Sofia.

Therefore the papers collected on this publication would like to offer lesson learnt and to be learnt, knowledge transferred and to be transferred, during that occasion.

In addition to this, we hope that looking at different experiences and sharing the best practices will increase interest to collaborate for the common benefit of the life long learning.

ACKNOWLEDGEMENTS

This book is very much the result of a team effort made by the participants to the Advanced Research Workshop “Control and risk prevention of dangerous materials and crisis prevention”, originally granted by the *Science for peace and security programme of NATO*.

A specific mention is also gratefully acknowledged to Hristo Smolenov, Director of Citizens’ Union for the National Guard (CUNG) and co-director of the event, and to his collaborators for the important cooperation in all the phases of workshop realization.

I am particular indebted to all the speakers and all the participants to the workshop and to all the authors of this publication, first of all for their effective contributions to the success of the whole project, and furthermore for the collaborative and constructive approach during the virtual and not virtual time spent together.

My sincere thank to Ms Mariana Jekova, Project Manager at CUNG and Mr Alberto Ceriani, Senior Expert at IReR, as members of the organizing committee; to Ms Alessia Pastorutti for the coordination of the project and the publication, and Ms Annalisa Mauriello for the logistics.

Allow me also to express my gratitude to IReR, through the President Adriano De Maio and to the Foundation for the Environment, FLA, through the President Paolo Colombani, and the Honorary President Giovanni Bottari, and the Director Fabrizio Piccarolo for the financial support to the project.

The book has benefited from many discussion we had with a wide range of professionals, civil servants and academic researchers to whom I am grateful for their insights and among which I would like to acknowledge the valuable contributions of the Directorate General of Civil Protection and Prevention Unit of Lombardy Region, through the director general Mr. Marco Cesca and, in particular, Mr. Andrea Zaccone and Valeria Chinaglia for their constructive criticism.

Last but not least, these acknowledgements are also addressed to all the people even not expressly mentioned for their valued support and energy that have made all this possible.

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From 1987 to 2001 was member of the Board of CESAER.

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Antonio Ballarin-Denti is full professor of Environmental Physics and chairman of the Department of Mathematics and Physics at Catholic University of Brescia (Italy). He is also director of the Research Centre for Environment and Sustainable Development (CRASL) of the same University.

He developed his scientific career at the National Research Council (CNR) and other Universities addressing his investigations first to cell biochemistry and biophysics and later to the impacts of atmospheric pollution and climate change on ecosystems and environmental risk assessment.

Professor Ballarin-Denti has been research associate and visiting professor at Yale University (USA) and has published more than 150 scientific articles, books and dissemination papers.

Since 1996 he has been appointed as Scientific Coordinator of the Lombardy Foundation for the Environment, established by the regional administration of Lombardy jointly with five major Universities of the region.

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Mr. Sandro Calvani

In July 2007 the UN Secretary-General Ban Ki-moon has appointed Mr. Sandro Calvani from Italy as the eighth Director of the United Nations Interregional Crime and Justice Research Institute (UNICRI) since its establishment in 1967.

In his 28 years career as executive of International Institutions, Mr. Calvani worked or lived in 135 countries, including the worst crisis scenarios. He is the author of 18 books and more than 600 articles on sustainable development, narcotics trafficking and transnational organized crime.

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From 2005, he is director of the National Project “ARCHAEOMET” Archaeometrical studies on gold, silver and bronze ancient museums objects using nuclear and atomic methods.

Fellow of the European Physical Society; he has been awarded of the Romanian Academy Awards for Physics “Dragomir Hurmuzescu” on 1986 and on 1991 for studies on various samples using nuclear elemental analysis methods at Bucharest Cyclotron.

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Mr. Carmelo Di Mauro

Carmelo Di Mauro obtained an MSc degree in Environmental Engineering at the Polytechnic of Milan. He has 15 years of experience in the field of risk analysis. His research activity is mainly focused on risk assessment and risk management methodology, in risk-based decision support tools and risk mapping. His experience started in 1994 in the field of waste management and environmental assessment of waste treatment plants. In 1998, the European Commission, within the Marie Curie Framework Program for the mobility of researchers in Europe, financed a two years research project that he developed at TNO (Institute of Environmental Sciences, Energy Research and Process Innovation) in the Netherlands. During the last eight years, he worked for the European Commission DG Joint Research Center (JRC). According to the institutional mandate of JRC, he participated to the development of research projects in order to support the definition and the implementation of new European policies. Last December he received a “JRC Excellence Award” for technical and scientific support to the development of a Council Directive on “Identification and Designation of European Critical Infrastructures and the assessment of the need to improve their Protection” - in the Support to EU Policy category (Council Directive 2008/114/CE).

Ms. Gonca Tuncel

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Mr. Giuseppe Pastorelli

Mr. Giuseppe Pastorelli holds a degree in Hydraulic-Sanitary Engineering (1990), Ph.D. in Sanitary Engineering (1995) and he is a Senior Environmental Engineer.

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Project manager of the industrial and natural risk research sector with Fondazione Lombardia per l'Ambiente since 1995, he has been involved in the last three years (2006-2009) in regional scale (Lombardy) research projects on integrated risk management (natural, technological and social risk), transport of dangerous goods and integrated risk area planning.

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Mr. Alfredo Romano

Mr. Alfredo Romano has been working in several project in risk analysis and development of Emergency Plan in different sectors: chemical, oil&gas, offshore, iron and steel industry and pipeline.

He specialised in management and development of maths model for simulation and evaluation of physical effects due to bad-functioning in the process industry and in transport system, such as fire, explosion, release of toxic gas, as well as reliability and availability analysis of industrial plant and service networks.

He participates, as chairman, on several conferences and workshops both in Italy and abroad and has published several articles on specialised journal.

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He has participated as reporter at seminars and symposia as well as teacher training at courses organized by ENI, AGIP, Ministero dell'Interno, Ministero dell'Ambiente, Politecnico of Milano and Turin, JRC Varese, CPI (Centro de Perfeccionamiento del Ingeniero Associació d'Enginyers, Industrials de Catalunya, Barcellona).

He has cooperated with the direction of the magazine ENI "Safety at Work" and he is secretary and member of the Directive Committee of 3ASI Associazione Analisti Affidabilità e Sicurezza Italiana (3ASI - Italian Reliability and Risk Analysis Association).

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He worked as a Director at the Environment Regional Agency where he worked in Hydrogeology, reclaimed lands works, and risks valuation.

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IEG NAS and MES of Ukraine come under the authority of the Ministry of Emergencies and National Academy of Science of Ukraine and gives scientific support to the Ministry of Emergencies.

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CONTROL AND RISK PREVENTION OF DANGEROUS MATERIALS AND CRISIS MANAGEMENT

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1. Introduction

Nowadays, we are all facing a period of transition which cannot be considered only from its structural perspective, but should be seen as a conjectural one.

The Post-Cold War world has overcome the barriers, unifying Europe, improving the Balkan situation, enlarging NATO and the EU; but, at the same time, it has shifted from a simple scenario to a more complex and unexpected globalized context: from the two geopolitical blocks, a transition to new political and territorial geography has taken place.

In this framework, new risks are emerging and crisis situations seem to easily penetrate the territories, even if security and safety concepts are not necessarily peculiar to the geography of the territory itself, at the present. In fact, many people wonder whether the world was more secure in the past than today, or whether the question is a matter of psychological perceptions instead.

This publication intends to answer this question by connecting the concepts of security and safety, particularly focusing on the perspective of transportation of dangerous materials.

On the world map, many areas of instability can be highlighted at national and trans-national level, along with the identification of conventional and non-conventional threats, such as in the energy, environment, migration, financial and food sectors; meaning that the international scenario increasingly and rapidly changes under emerging new factors and needs.

Therefore, to face this global situation, new tools are necessary to replace the traditional ones that need to be updated; it has been learned that the traditional linkage, threat – law – control, created a virtuous cycle that nowadays is inadequate. Furthermore, repression does not represent the only possible way forward; it does not even represent the simplest one, nor always the most effective.

Consequently, also the linkage and the concepts of security/safety have begun to suffer from the weakness of reaction and preparedness of the tools, as the present situation shows: the financial and economic crisis has brought some changes also from the psychological point of view.

This new perception offers the possibility to look at the situation from different perspectives, among which it is possible to assume the concept of crisis as an opportunity opposing new organizational structures against the new risks. For example, environmental safety and safer transport imply the need to fight against criminal infiltration and corruption.

In this case, insider risk can be considered as a threat not limited to fraud: sabotage, negligence, human error and exploitation by outsiders are also to be included. As shown during the NATO workshop, in radiation and nuclear experiments especially, most of the accidents have been provoked, accidentally or on purpose, by scientists. This has been statistically shown to contradict the perception that most of the cases are a consequence of terrorist attacks.

To summarize, the rapid evolution of problems and problematic situations calls for reactive and continuously updated tools of response.

This prompt reaction can be structured through global analysis and commitment, to be achieved in the framework of trans-national responses and plans. In fact, policies based on the principles and values of democracy can help towards these objectives.

Therefore, it is possible to envisage some possible tools, such as follows: multi-level vision and coordination, proactive coordinated approach, complementarity, development of threat management and a multidimensional approach.

Concerning multi-level vision and coordination (international, regional-national and local) fundamental steps have to be considered for the integration of safety and security matters: all forms of expertise can be collected, coordinated and integrated in order to cope with destabilizing factors and trans-national threats. In particular, specialized international agencies, regional organizations and individual experts can contribute tremendously in this sector, through the combination of a variety of knowledge and expertise.

For example, talking about transport of dangerous materials, safety and security dimensions can be considered at one time, based on a top-down or bottom-up multi-level vision and strategy.

In relation to this, the experience of Lombardy Region on transportation of dangerous materials (half of the total transport in Italy) represents a best practice of multi-level vision and coordination that has been put at the disposal of different entities, gathering various subjects during the NATO workshop in order to compare methodologies and models of civil prevention with models of anti-terrorism measures, while transferring and learning methods and know-how for the common intellectual and managerial benefit and growth.

Contributions from the Balkans and other European countries had the floor during the event in order to define a common approach by illustrating different needs and realities. Particular attention was given to the Research Centres and to multi-level experience and expertise, with the aim of learning and spreading knowledge from different interacting perspectives.

Therefore, these are the key words to be considered: multi-level vision based on different knowledge, experience and expertise; and local, national, international and multi-level coordination through interaction of different subjects involved.

These key words need to be linked together in order to establish a coordinated approach in which security and safety can be mutually integrated and, particularly, security can transfer problem-solving expertise and management to the field of safety, so that safety can activate prompt, proper and adequate responses to crisis and emergency situations.

A second item that should be considered in the analysis is a proactive coordinated approach.

As previously said, safety and security are multi-disciplinary concepts that represent a present and a future challenge to be addressed domestically and externally. The empowerment and the ownership of the subjects at different levels facilitated somehow the ‘creativity’ towards the invention of new and more sophisticated threats.

Nonetheless, it should also be noticed that the power spreading in the globalized world emancipated the local subjects towards more interactive solutions, which are fundamental for the reaction. In fact, traditional paths are no longer sufficient to face the new context: it is necessary to improve the capability for timely detection and understanding of new trends. To that end, the further development of analytic tools might represent a way forward in a reacting multi-level and interacting perspective.

As an example of how this concept may be applied to the transport of dangerous materials, two points of view can be distinguished: a general and a specific one.

Generally speaking, a proactive approach relative to transport of dangerous materials could be linked to resilience and sustainability concepts. In fact, resilience is connected to the capacity of the system to absorb the shocks and react to them. Moreover, reaction is a consequence of the self-organization capacity of the system, and finally, the degree to which the system can build capacity has to be considered and evaluated in a proactive approach.

When resilience cannot be applied, territory – which does not correspond necessarily to defined political dimensions – suffers from vulnerability because the system is exposed to risks, meaning that the system has not activated a proactive approach responding rapidly to crisis situations.

Concerning the sectorial point of view, the Lombardy's PRIM project, Integrated Regional Plan for major risk Mitigation, can be taken as an example. It is a policy-oriented strategy for integrated risk assessment and management, representing a best practice to be taken into consideration for a proactive approach in decision-support systems addressed to local safety and security policies, while stimulating governance strategies oriented to risk prevention and mitigation.

In fact, the project aims are significant in proactivity, since they tend to identify most critical areas, where the combined action of some major risks should be urgently contrasted. Furthermore, the PRIM aims at developing a risk mitigation strategy for these areas as a primary objective of regional public policies.

Therefore, these examples show that a proactive approach, both from a general point of view and from the sectorial one, could help the actors and the system to be ready to respond quickly and jointly to safety and security emergencies.

The more the approach is integrated the more effective it will be, leading to greater efficiency: the resulting increase in operational coordination will ensure a timely response to the challenges.

Moreover, a more comprehensive approach, which aims to respond to global crisis, requires an interdisciplinary approach that mobilizes security tools, diplomacy, aid and financial tools in a coherent and complementary manner.

The meaning of complementarity can be practically understood by looking at the structure of the NATO workshop on 'Control and risk prevention of dangerous materials and crisis management', which, starting from a general perspective, went deeper into the subject, illustrating different aspects and levels while taking into consideration the theoretical and practical experiences with the aim of integrating various tools and making them complementary.

In particular, during the NATO workshop it was demonstrated, as mentioned above, that the traditional linkage of threat – law – control is inadequate, but on the other hand the legal framework is necessary, especially looking at the integration of the new (pre-accession and accession) countries within the European Union.

Secondly, territorial vulnerability and risk analysis were considered. Concerning territorial vulnerability, many items were illustrated in safety and security, with a possible linkage between the two issues for mutual benefit.

Therefore, geography and mapping of dangerous substances, vectors of transportation, types of carried materials, routes of transportation (highways, roads, oil pipelines, sea and river, railways), types of territory involved (high density of population, not populated) were illustrated.

Furthermore, the sustainable development perspective was presented with the aim of putting forward the analysis and application of the methods with an eye to the future, and particularly for the sake of future generations.

Then, going deeper into the subject, risk analysis was conducted through the possible identification of the most critical area and the development of a risk mitigation strategy, by banning the transportation of dangerous materials in a

certain area; presenting and implementing models for calculating individual and social risks originating from different types of transportation; mapping critical areas by matching risks and cartography; analysis of risk sensitivity on different vectors and routes. Risk management in critical infrastructures, particularly in aviation security, was also been illustrated by the Bulgarian experience.

Analysis continued in the second session by presenting a series of case studies that included examples from Albania, Bulgaria, Italy and Romania from different levels: the territorial level, represented by Regional expertise; the National one, represented by different countries and government representatives, and the European and International levels through their officers' perspectives.

Therefore, the workshop achieved its objectives, which among others, may be listed in the following results:

- Presenting the experience of Lombardy Region on the transportation of dangerous materials
- Developing and implementing models of calculation of social and individual risks
- Methods of mapping critical areas
- Crisis management and quick response to crisis situations
- Repeatability of criteria, methods and models in different geographic and sector areas.

Furthermore, the results emerging from the workshop contribute to a wider idea of complementarity, which includes, among others, the following tools to be considered, and that summarize also the items already described:

- lifelong learning;
- coordination at all levels;
- networking;
- multi-level education.

Complementarity means, basically, integration between tools and subjects at different levels, not only among them, but also within them. In particular, concerning lifelong learning, which should be addressed to all levels and particularly at government levels (training of politicians); the following sources should be specified:

- from events, when they occur, so as to be ready and prepared to react and respond rapidly on the next occasion;
- from experience, to understand the best way to deal with situations as they arise;
- from monitoring and control, to prevent possible or probable crisis situations and to develop new models;
- from models, especially from risk analysis models, to adapt the traditional tools of response creatively to new threats with the aim of innovating the tools.

Coordination at all levels has already been treated; therefore passing to the networking, it can be said that this allows and facilitates information transmission and enhances collaboration and partnership and, most importantly, establishes a network of subjects oriented to the achievement of common objectives.

Networking might also help to weave a strong and flexible net, able to apply innovative models to reality, drawn from monitoring experiences while hopefully facilitating multi-level education.

In fact, this concept is a kind of melting pot in which all above-mentioned items could be mixed, and mastered through properly skilled management that introduces a new development of threat management.

Effective threat management embodies the actions that organizations must take to defend themselves against today's new, unexpected threats. These actions form an "intrusion prevention" and protection lifecycle where each stage provides critical information to the next.

These actions must include fortifying the environment through proper threat research and scanning, monitoring the network infrastructure for signs of malicious activity, responding to any incidents that do occur and, finally, conducting incident analysis through data mining to discover areas that need additional strengthening. By developing an integrated threat management, actors will be able to achieve intrusion prevention and protection at all levels together with reactive response to crisis.

Furthermore, threat research and scanning represent the proactive threat management measures necessary to prevent intrusions across a certain area. Through research, the system collects intelligence data on the emerging vulnerabilities and threats that will impact on its infrastructures, and with workflow management capabilities, enable security teams to track new threats through to their resolution.

These resolutions might be achieved by a multidimensional approach as previously shown, for example talking about the PRIM project that offers a technical dimension and solution, while the Bulgarian experience stresses the subjective dimension of the approach to emergency and crisis situations (for instance, at borders in the transport of dangerous materials), including human error, skilled personnel, training, and so on.

Therefore, the multidimensional approach is the result of a combination of actions and tools of different levels of power applications, which can represent a mirror collecting information and intelligence to be reflected on safety and security strategies against new emerging risks.

PART I

GEOPOLITICAL OVERVIEW AND JURIDICAL ASPECTS

GEOPOLITICAL OVERVIEW: SAFETY AND SECURITY IN WESTERN AND EASTERN EUROPE WITH PARTICULAR REFERENCE TO NEW TRENDS. HIGHLIGHTING NEW THREATS AND AN INNOVATIVE APPROACH TO THE NECESSARY REGIONAL KNOWLEDGE MANAGEMENT SYSTEMS

SANDRO CALVANI
UNICRI Director

Abstract The use of weapons of mass destruction by terrorist organizations and other non-state actors is one of the biggest threats to international security.

In order to prevent such groups from obtaining the means to cause destruction and death on a major scale, it is imperative that governments, international organizations and other stakeholders work together to prevent the illicit traffic of materials which could be used in the production of WMDs.

Therefore coordinated international action is needed to prevent the trafficking of CBRN material, which could be used by rogue elements to produce weapons.

Drawing from the UN strategy, UNICRI has developed the worldwide programme *Strengthening International Cooperation to Combat Illicit Trafficking and Criminal Use of CBRN Substances and Weapons*.

Within this framework UNICRI established regional Knowledge Management Systems with the objective of facilitating the flow of information among states, using the existing knowledge and data to develop common strategies and response mechanisms.

1. New Threats

The use of Weapons of Mass Destruction (WMD) by international terrorist groups and other non-state actors is considered to be one of the biggest threats to global safety. To prevent non-state actors from acquiring WMD, illicit trafficking in chemical, biological, radiological and nuclear (CBRN) material should be prevented. There are three factors that make the prevention of CBRN material an urgent issue:

Firstly, as a result of several different causes, including the change of national boundaries, easier cross-border mobility, the dismantling of a major portion of the nuclear weapons programme in the former Soviet Union and the expansion of criminality, non-state actors may potentially be able to acquire CBRN materials, transform them into CBRN weapons and then use them as WMD. Even though there have been no cases in which terrorists successfully caused mass deaths through CBRN materials, a number of terrorist or criminal organizations have tried to develop and deploy WMD in the last few years. In 1995, the Aum Shinrikyo cult released the chemical agent Sarin in the Tokyo subway system, 12 people died and many were wounded. Although the cult did not cause mass destruction, the nature of the attack drew attention to terrorists' desire to use weapons of mass destruction (WMD).

Secondly, due to technical innovation, a simple nuclear weapon, such as a gun-type device, even though highly sophisticated in the 1940s, is no longer impossible to produce for non-state actors. Moreover, recent advances in biotechnology, nanotechnology and information technology entail easier and faster technological development at lower cost. This also means that a growing number of actors are able to exploit technical innovation, while it gets harder to determine non-compliance and implement enforcement.

Finally, the existing responses or strategies are not suitable for the new threats posed by illicit trafficking in CBRN material. Up to now, legal norms and international treaties were the main instrument available to the international community for preventing a state from developing CBRN capabilities. Political leadership was also an available instrument to stop proliferation, including retaliation as the best deterrence for preventing a state from attacking another state with CBRN weapons.

However, the strategic validity of these instruments has become questionable with non-state actors, simply because there may be no address at which to deliver the response. Non-state organizations may be 'invisible' actors that cannot be identified with a specific country or area, do not leave any warnings before launching a terrorist attack, and leave the targeted country immediately after the CBRN attack. The use or the threat to use national or international countermeasures in case of a CBRN attack may be a powerless strategy against an enemy without a face. Not surprisingly, Resolution 1540 of the UN Security Council, adopted in April 2004, claimed that illicit trafficking in CBRN weapons 'adds a new dimension to the issue of proliferation and also poses a threat to international peace and security'.

In this respect, preventing violent non-state actors from obtaining CBRN material, weaponizing and using them as WMD seems to be not only the best strategy, but also the only one.

2. The UN Approach Towards the Problem of CBRN Material

The international concerns about chemical, biological, radiological and nuclear (CBRN) materials and weapons are not new issues. It was 1925 when the Geneva Protocol committed the signatory nations to refrain from the use of chemical and biological weapons after the employment of poison gas during World War I.¹ World War II witnessed the experiment of biological warfare, the use of poison gas and the deployment, for the first time in history, of nuclear weapons. Afterwards, the NATO and Warsaw Pact nations produced a significant amount of chemical, biological and nuclear weapons during the Cold War, especially from the 1960s to the early 1980s. This escalation led the international community to make efforts to restrain states from developing capabilities in the area of CBRN weapons. The result was a network of interlocking treaties, organizations and multi-lateral inspections that aimed to prevent the proliferation of Weapons of Mass Destruction (WMD). In particular, the Treaty on the Non-Proliferation of Nuclear Weapons (opened for signature in 1968), the Biological Weapons Convention (opened for signature in 1972) and the Chemical Weapons Convention (opened for signature in 1993) were created to halt the spread of WMD.

However, moving into the 21st century, the world community's attention is drawn to a new alarming aspect of WMD: the illicit trafficking and criminal use of CBRN material and weapons.

Hitherto, legal norms and international treaties were the main instrument available to the international community for preventing a state from developing CBRN capabilities. Political leadership was also an available instrument to stop proliferation, including retaliation as the best deterrence for preventing a state from attacking another state with CBRN weapons.

Even so, the strategic validity of these instruments has become more difficult to apply when dealing with non-state actors, simply because there may be no address at which to deliver the response. Non-state organizations may be 'invisible' actors that cannot be identified with a specific country or area, do not leave any warnings before launching a terrorist attack, and leave the targeted country immediately after the CBRN attack. The use or the threat to use national or international countermeasures in case of a CBRN attack may be a powerless strategy against an enemy without a face.

Not surprisingly, Resolution 1540 of the UN Security Council, adopted in April 2004, claimed that illicit trafficking in CBRN weapons 'adds a new dimension to the issue of proliferation and also poses a threat to international peace and security'. The resolution focuses on combating the production, acquisition and use of weapons of mass destruction and their means of delivery by non-state actors.

¹ Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare.

In line with the new challenges and priorities, the international community has re-shaped the political agenda. In April 2005 the UN General Assembly adopted the International Convention for the Suppression of Acts of Nuclear Terrorism. The Convention details offences relating to unlawful and intentional possession and use of radioactive material or a radioactive device, and use or damage of nuclear facilities.

On 8 September 2006, the General Assembly unanimously adopted the United Nations Global Counter-Terrorism Strategy (A/RES/60/288). The Strategy reaffirms the international community's firm resolve to strengthen the global response to terrorism. It is a unique global instrument that aims to enhance national, regional and international efforts to counter terrorism by elaborating a broad range of counter-terrorism measures, underpinned by the commitment to uphold the rule of law and human rights.

This new UN strategy to combat terrorism has inspired a new sense of ownership across all Member States. Instead of designing countermeasures through legally binding UN Security Council resolutions, terrorism is now confronted through an inclusive and holistic approach. In other words, this strategy is forged on consensus among all States.

To ensure overall coordination and coherence in the counter-terrorism efforts, the Secretary-General established in July 2005 the Counter-Terrorism Implementation Task Force (CTITF). The CTITF is a coordinating and information-sharing body that serves as a forum to discuss strategic issues and ensure coherent action across the UN system in counter-terrorism. Chaired by the Office of the Secretary-General, it consists of 24 UN system entities working together under mandates from the General Assembly, the Security Council, and various Specialized Agencies, Funds and Programmes.

3. UNICRI Activities

UNICRI, a UN entity specialized in Applied Research and a part of the Counter-Terrorism Implementation Task Force (CTITF), has contributed to the implementation of international agenda on the topic of WMD. With more than 35 years of international action, UNICRI has acquired unique experience in dealing with crime and justice problems within broader policies for security governance, socio-economic change and development, and the protection of human rights.

In line with the UN policy in the field of CBRN threats, UNICRI has developed the worldwide programme Strengthening International Cooperation to Combat Illicit Trafficking and Criminal Use of CBRN (chemical, biological, radiological and nuclear) Substances and Weapons. The aim of the Programme is to improve states' capabilities to prevent and combat the illicit trafficking and criminal use of CBRN material. More specifically, the programme aims to:

1. Strengthen the *exchange of information* on CBRN among national authorities and international organizations;
2. Develop a *CBRN unified analysis* that combines analysis on illicit trafficking and criminal use of CBRN material as well as other illicit material (such as drugs and small arms);
3. Improve *national expertise and responses especially on illicit trafficking of biological and chemical material* by transferring analytical outcomes as well as accumulated international and national experience.

The collection and exchange of information among countries and international/regional organizations is fundamental in order to intercept illicit trafficking in CBRN material and to restrain terrorists from obtaining material suitable for a CBRN attack. In particular, when the first line of defence fails (preventing unauthorized persons from stealing or illegally acquiring or developing CBRN materials), the sharing and use of information become vital to prevent the passage of CBRN materials into the hands of terrorists.

Obviously some information cannot be shared, especially when it concerns investigation procedures or other national interests. However, a rapid cross-border sharing on CBRN incidents (including kind of material seized or stolen) may help identify illicit routes promptly and deliver an effective response. Since several authorities and agencies are involved within and between countries, it is necessary to establish clear channels of communication and allocation of responsibilities to ensure a rapid and effective flow of information and optimize efforts. Failure to collect and share information among these bodies would make analysis more difficult and preventative strategy weaker.

At present, there are different obstacles (for example no clear communication channels, lack of harmonization of definitions and standardization of data collection) that hamper an effective and rapid sharing of CBRN-related information. These obstacles are present within country, between agencies of different countries and between countries and international organizations.

4. UNICRI Innovative Approach Towards Regional Knowledge Management Systems

In order to address the problems discussed above, the European Commission relied on UNICRI to develop regional Knowledge Management Systems, which promote sharing of information, best practices, and lists of national and regional experts.

The aim of the systems is to promote and improve the exchange of information and knowledge among States, and between States and International/Regional Organizations through a permanent and standardized process of collection, management and dissemination of technical data and information on illicit trafficking of CBRN materials.

International and Regional organizations are very important actors in the field of the prevention of illicit trafficking of CBRN weapon usable material and play a significant role within the system. The Knowledge Management System has been established with the technical support of the International Atomic Energy Agency, the Organization for the Prohibition of Chemical Weapons, EUROPOL, the SECI Center and the World Customs Organization.

The systems facilitate the interaction of the national experts and representatives from international/regional organizations through high quality and secure IT connections. The Knowledge Management System will assist the participating countries in:

- **Promoting and improving the exchange of information** and knowledge among countries, and between countries and international organizations. Through the system, the participating States will have access to information that will help them fulfil their obligations in terms of United Nations Security Council Resolution 1540, paragraph 3 (points c and d), concerning the development of appropriate measures in the areas of effective border controls, law enforcement efforts to detect illicit trafficking of CBRN material, and national export controls and trans-shipment controls.
- Elaborating and promoting analytical tools to produce **regional risk assessments** and identify overall national vulnerabilities and needs on illicit trafficking of biological and chemical material.
- **Improving countries' expertise** in preventing illicit trafficking of chemical and biological material by exploiting and managing accumulated experience and knowledge.
- **Harmonize policies and measures** to prevent incidents of illicit trafficking of biological and chemical material.

Within the Knowledge Management System Project UNICRI plays the role of facilitator, providing a platform for all different stakeholders, States and organizations, to share information and expertise, and seeks to provide States with a sense of ownership of the system. Eventually the system should become self-sustainable, becoming a stable instrument that improves States' capabilities to prevent illicit trafficking of CBRN weapon usable material.

The pivotal point of the Knowledge Management System is that it intends to make full use of the capabilities and experience of the participating International/Regional Organizations. Lessons learned and good practices already exist, especially in the field of preventing illicit trafficking of radiological and nuclear material. Rather than 're-inventing the wheel', the project aims to assist States in absorbing these countermeasures and encourage them to develop an organizational learning approach through which States' experts would learn collectively how to identify problems/solutions by incorporating and adapting experiences that are made within the system.

Addressing the threat of illicit trafficking of chemical, biological, radiological and nuclear (CBRN) material in today's world is different from addressing the legacy of Cold War in the former Soviet Union. The growing nuclear energy demand, biotechnology development and pandemics will without any doubt be accompanied by increased non-proliferation challenges, and in particular the threat of illicit trafficking of CBRN material.

UNICRI, in cooperation with the European Commission and the technical support of international and regional organizations, launched the first Knowledge Management System in 2008, in the region 'South East Europe and the Caucasus'. The second Knowledge Management System, which focuses on North Africa and some countries in the Middle East, is launched in March 2009. The Systems, designed to improve coordination between countries and international/regional organizations, will make a significant contribution to implementation of innovative policies to promote a culture of security.

A LEGAL FRAMEWORK ON DANGEROUS SUBSTANCES: AN INTERNATIONAL, EUROPEAN AND NATIONAL PERSPECTIVE

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Abstract This paper aims at providing a very general view of the main issues, focusing on two different issues, where Fondazione Lombardia dell'Ambiente has developed special areas of research: the application of the Seveso directives in an enlarged Europe and the Environmental Liability Directive.

1. Introduction

The legal framework on dangerous substances is quite vast and complex today, but we might focus on four main topics that correspond to four main strands of our legislation:

1. Labelling, Packaging, Wastes
2. Prevention of Accidents where dangerous substances are involved
3. Transportation
4. Liability for harm caused

From the very beginning we might also sketch out some differences in operating in these tools. In fact, the three first topics correspond to mechanisms of administrative law, which use a command and control approach as a tool to control the authorization of activities. In case of violation of the legislative provision, the operator will have to pay a pre-identified sum (fine, penalty).

In the fourth case, instead, liability for harm caused is a private law mechanism. In case of injury, the liable person will have to pay *damages*, depending on the specific value of the injured goods.

Where the injured goods are natural resources, problems of quantification often arise.

This paper aims at providing a very general view to the main issues, focusing on two different issues, where Fondazione Lombardia dell'Ambiente has developed special areas of research: the application of the Seveso directives in an enlarged Europe² and the Environmental Liability Directive³

2. Labelling, Packaging, Waste

The aim of labelling, packaging and wastes legislation is to follow the 'dangerous' substance from cradle to grave, to allow a life cycle assessment, or the investigation and valuation of the *environmental impacts* of a given product or service caused or necessitated by its existence.

These are rules that are strongly influenced by scientific knowledge. One important piece of legislation at EU level is the Regulation on Registration, Evaluation, Authorization and Restriction of Chemicals (REACH), which came into force on 1st June 2007⁴.

From a general point of view, the REACH Regulation improves the former legislative framework on chemicals of the European Union.

The main tasks of REACH are to improve the protection of human health and the environment from the risks that can be posed by chemicals, but also the promotion of alternative test methods, as well as the free circulation of substances on the internal market in order to enhance competitiveness and innovation.

Finally, REACH should make industry more responsible for assessing and managing the risks posed by chemicals and providing appropriate safety information to their users.

More recently, a big effort has been made in order to harmonize the criteria for classifying, labelling and packing chemical products.

The EU, for example, has put into force a new Regulation on classification, labelling and packaging of chemicals based on United Nations Globally Harmonized System of Classification and Labelling of Chemicals (GHS).

The so-called GHS is a United Nations system to identify hazardous chemicals and to inform users about these hazards through standard symbols and phrases on the packaging labels and through safety data sheets (SDS).

On 16 December 2008 the European Parliament and the Council adopted a new Regulation on classification, labelling and packaging of substances and mixtures (CLP) which aligns existing EU legislation to the GHS.

² Seveso trent'anni dopo: la gestione del rischio industriale, a cura di Achille Cutrera, Giuseppe Pastorelli e Barbara Pozzo, Milano, Giuffrè, 2006. The Implementation of the Seveso Directives in an Enlarged Europe, *A look into the Past and a Challenge for the Future*, Kluwer Law International, edited by Barbara Pozzo, 2009.

³ La responsabilità ambientale, La nuova Direttiva sulla responsabilità ambientale in materia di prevenzione e riparazione del danno ambientale, a cura di Barbara Pozzo, Milano, Giuffrè, 2005.

⁴ Regulation 1907/2006, consolidated version 23.11.2007.

The new Regulation came into force on 20 January 2009. The deadline for substance classification according to the new rules will be 1 December 2010, and for mixtures, 1 June 2015. The CLP Regulation will ultimately replace the current rules on classification, labelling and packaging of substances (Directive 67/548/EEC) and preparations (Directive 1999/45/EC) after a transitional period⁵.

3. Accident Prevention: The Seveso Directives

Legislation against pollution, at nation or supranational level, cannot in itself prevent serious industrial accidents that are catastrophic for the environment, like those in Seveso in Italy in 1976 and Bhopal in India in 1984.

For that reason, rules should be taken concerning controls on land-use planning when new installations are authorized and when urban development takes place around existing installations.

3.1. THE FIRST SEVESO DIRECTIVE

Since the early eighties the Seveso Directives have provided a legal framework of reference for rules governing major accident hazards in Europe which, on the one hand, has consistently extended its powers in environmental matters thanks to the numerous amendments made to the Treaty and, on the other hand, has gradually become a community 'open' to those requesting to become a member. The first Directive on *the major-accident hazards of certain industrial activities* (Directive 82/501/EEC)⁶ was introduced on 24 June 1982.

Lacking a specific community competence in environmental matters, which was conferred only four years later thanks to the Single European Act in 1986, the said Directive centred its legal basis on articles 100 and 235 of the Treaty⁷.

Directive 82/501/EEC was introduced during the period in which the Community began to identify the major principles on which its environmental policy was to be based: the principles of preventive action and participation/information of the population, principles which had already been formulated in the first action programme and then were defined in the second action programme.

⁵ Regulation (EC) No 1272/2008 of the European Parliament and the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006, Official Journal 31 December 2008, L 353/1.

⁶ O.J., Law nr. 230 of 5 August 1982 pp. 1.

⁷ In particular, the Council of the European Communities mentioned article 100 and 235 at the beginning of the Directive ("Having regard to the treaty establishing the European Economic Community, and in particular articles 100 and 235 thereof") and in the last recital.

These are the principles which constitute the new Directive and can be found after a first reading in the recitals⁸. In particular, the text of the Directive emphasized how *information and prevention* were closely related one to the other⁹.

At the same time, the control on prevention measures and on information implied limiting the role of the public administration and the tasks of the industries, as well as defining the role of citizens and workers.

The preventive action principle¹⁰ was expressly recognized by article 1 of the Directive, which had as a major objective 'to prevent major accidents which could be caused by certain industrial activities, as well as to limit their consequences for man and the environment ...'¹¹.

The prevention system was therefore centred on certain industrial activities¹², specifically classified as establishments¹³, or as storage facilities for dangerous substances¹⁴ in related Annexes.

⁸ The first recital of the Directive dated 1982 established that: "Considering the objectives and the principles of the Community's environmental policy set out in the action programmes of the European Communities on the environment dated 22 November 1973 (4) and 17 May 1977 (5), in particular, the principle according to which the best environmental policy consists in preventing pollution and other hazards from the beginning; and it is therefore necessary to study and focus technical progress on the necessity to protect the environment;"

⁹ For example, the sixth recital of the Directive underlines that "training and providing people who work on site with the necessary information may play an important role in preventing major accidents and controlling the likelihood of such accidents". At the same time, the Directive established in art. 12 that the Commission should create a register of major accidents occurring in the territory of the Member States at the disposal of the latter, including an analysis of the said accidents, any information regarding the event and the measures taken, in order to allow the Member States to use this information for prevention purposes.

¹⁰ The preventive action principle is indicated among the objectives of the Community's environmental policy as from the first action programme, cit., C 112/5 and is later mentioned in the second action programme, cit., C 139/6.

¹¹ As in art. 1, nr. 1 of the Directive 82/501/EEC.

¹² The industrial activity taken into consideration in the Directive was defined in art. 1, nr. 2 a. and consisted in "any process carried out in industrial facility under Annex I which require or may require the use of one or more dangerous substances which may be a source of major-accident hazards, as well as the transportation inside the facility"; in alternative, the Directive considered the storage facilities as per Annex II.

¹³ *Annex I*, referred to in the Directive under the definition of industrial activity (art. 1 nr. 2 a) regarded in particular: 1. industrial facilities for the production and the transformation of organic or inorganic chemical substances used in particular processes contemplated by the said Annex; 2. facilities for the distillation or refining, or other successive transformation of oil from petroleum products; 3. facilities used for the total or partial elimination of solid or liquid substances through combustion or chemical decomposition; 4. facilities for the production or treatment of gas for energy purposes, such as liquefied petroleum gas, liquefied natural gas or synthetic natural gas; 5. facilities for the dry distillation of coal gas and lignite; 6. facilities for the wet or power production of metals or metalloids.

¹⁴ In this sense, the Directive could have taken into consideration separate storage facilities differing from those indicated in Annex I containing particularly dangerous substances such as flammable gas, extremely flammable liquids, ammonia, chlorine, etc.

The Directive established the obligation for those in charge of the aforesaid industrial activities to take the necessary steps to prevent major accidents and to limit their consequences for man and the environment¹⁵, as well as to identify any existing major-accident hazards at the establishment and to take the proper safety measures.

The above-mentioned major obligations were closely connected to the obligation to inform and to train people working within the said facilities¹⁶.

These generically worded obligations were related to the specific obligation to inform the Competent Authorities¹⁷, in the event that highly dangerous substances were used within the establishment and mentioned in a specific Annex¹⁸.

The purpose of the notification was to provide the Authorities with relevant information, concerning in particular:

- a. *substances* used in the industrial process;
- b. *industrial establishments*, and in particular: their location, the workers exposed to work-related risks, the ongoing technological processes; specifically, a detailed description of the areas within the establishments deemed important from a safety point of view, of the hazard sources and of the conditions under which a major accident could occur, as well as a description of the preventive measures planned;
- c. in the event of possible *major accidents*, emergency plans, including safety equipment, alarm systems and resources available for use inside the facilities in case of major accidents, as well as any information which should be given to the competent authorities in order to enable them to prepare emergency plans outside the facilities.

Moreover, the Directive provided that Member States appoint an *Authority or Competent Authorities*¹⁹ to receive the notification, to examine the information contained therein, as well as to supervise and ensure that an emergency intervention plan was prepared to be used outside the establishment. In addition, the competent authorities were authorized to request further information deemed necessary in

¹⁵ Art. 3 of the Directive 82/501 established: "Member States shall take the necessary steps so that, for all industrial activities defined under article 1, the manufacturer shall be obliged to take all the necessary steps to prevent major accidents and to limit their consequences on man and on the environment".

¹⁶ Art. 4 of the Directive established: "Member States shall take the necessary measures so that each manufacturer shall be obliged to prove to the Competent Authorities, at any moment and for inspection purposes as under article 7, item 2, to have identified existing major-accident hazards, to have informed, trained and given the necessary equipment, for safety purposes, to the people who work on the site".

¹⁷ Cf. art. 5 of the Directive.

¹⁸ Annex 3 to the Directive identified a list of 178 substances deemed relevant for the implementation of art. 5 of the Directive.

¹⁹ Cf. art. 7 of Directive 82/501/EEC.

order to ensure that the manufacturer put in place the most appropriate measures concerning the numerous operations carried out by the industrial activity, in order to prevent major accidents and adopt the measures necessary to limit their consequences. In particular, the competent authorities were authorized to organize *inspections and other control measures*, related to the type of activity concerned, in accordance with national regulations.

Even the *principle of information*²⁰ was introduced in detail for the first time in the Directive of 1982, with regards to the numerous aspects involved in a major-accident scenario.

An obligation to provide *public information* to those potentially involved in a major accident, including safety measures and rules to be followed in the event of an accident²¹.

At the same time the *obligation to inform* was also interpreted as an obligation on *managers of industrial activities towards the Competent Authorities*. As a matter of fact, in the event of a *major accident*²², the ‘manufacturers’²³ were obliged to inform the Competent Authorities as to the circumstances of the accident, the dangerous substances involved, the data available for assessing the effects of the accident on man and the environment, and the emergency measures taken. The manufacturers were also obliged to inform the authorities of the measures envisaged to alleviate the medium- and long-term effects of the accident and to prevent any recurrence of such an accident²⁴.

Always in terms of information, art. 18²⁵ of the Directive defined the principle according to which *Member States and the Commission* were requested to exchange any information in their possession regarding the prevention of major accidents and the limitation of their consequences, in particular concerning the implementation of the provisions set out in the Directive²⁶.

Finally, it was established that five years after the notification of the Directive, the Commission was obliged to deliver a Report on its implementation to the

²⁰ As from the first action programme, the issue concerning education and environmental information had been inserted among the objectives of the Community’s environmental policy. In particular, see the second action programme, O.J. C 139/41.

²¹ In this regard, see art. 8 of Directive 82/501/EEC.

²² For the purposes of this Directive, “major accident” means “an occurrence such as a major emission, fire or explosion resulting from uncontrolled developments in the course of an industrial activity, leading to a serious danger to man, immediate or delayed, inside or outside the establishment and/or to the environment and involving one or more dangerous substances”.

²³ According to the terminology used in the Directive under art.1. nr.2 b), “*manufacturer*” means “*any person in charge of an industrial activity*”.

²⁴ As provided for in art. 10 of Directive 82/501/EEC.

²⁵ Art. 18 was then amended by Council Directive 91/692/EEC of 23 December 1991, the so-called Horizontal Framework Directive, see *infra*. Cf. sub 5.1.3. of this chapter.

²⁶ As provided for in art. 18 of Directive 82/501/EEC.

Council and to the European Parliament, on the basis of the aforesaid exchange of information. The first Report on the implementation of the «Seveso» Directive in the Member States was then submitted to the Commission on 18 May 1988²⁷.

The **first amendment** to the first «Seveso» Directive was made by Council Directive 87/216/EEC on 19 March 1987²⁸, which only corrected and clarified some aspects and levels of limitation indicated by Annexes I, II and III to the Directive in order to avoid diverse interpretations concerning the scope of the Directive and to ensure the most appropriate implementation by Member States.

A **second amendment**, which was more incisive, was introduced a year later by Council Directive 88/610/EEC of 24 November 1988²⁹.

Following an accident in a Sandoz warehouse which caught fire on 1 November 1986 in Basel, Switzerland, a second amendment to the «Seveso» Directive was made in order to extend the scope to establishments storing dangerous substances, thus adding a new list of dangerous substances³⁰. Moreover, the said Directive inserted a new Annex VII, containing information to be given to the public in the event of an accident.

Finally, a **third amendment** was made in 1991, thanks to Council Directive 91/692/EEC of 23 December 1991³¹, the so-called *Horizontal Framework Directive*, which was designed to standardize and rationalize reports on the implementation of certain directives relating to the environment.

Directive 91/692/EEC took into consideration the fact that some Community Directives relating to the environment required Member States to prepare a report on the measures taken to implement them. These reports were used by the Commission to draft a consolidated report, but on the other hand, the existing provisions regarding the preparation of reports stipulated different intervals between reports and established different requirements for their content. Therefore, a proposal to harmonize the existing provisions in order to make them more complete and more consistent was made, by establishing that Member States should draw up and submit the reports to the Commission at an interval of three years, with a one-year interval between sectors; in addition, requiring that the reports be based on a questionnaire produced by the Commission with the assistance of a committee and sent to the Member States six months before the start of the period referred to by the report; and, finally, establishing that the Commission publish a consolidated report on the sector concerned within nine months of Member States' submission of their respective reports.

This Directive integrally substituted art. 18 of the first Directive, introducing a new provision according to which the Commission must draw up three-yearly

²⁷ COM (88) 261 def. See cf. *infra*, sub 5.1.4.

²⁸ O.J. L 85 of 28.3.1987, pp. 36.

²⁹ O.J. L 336 of 7.12.1988, pp. 14.

³⁰ The new list appears in the new Annex II to the Directive.

³¹ O.J. L 337 of 31 December 1991, pp. 48.

reports, starting from the period 1994–1996. The first report was published by the Commission in 1999³².

3.2. THE IMPLEMENTATION OF THE FIRST «SEVESO» DIRECTIVE BY THE MEMBER STATES AND THE CONTROL MEASURES TAKEN BY THE COMMISSION

The final date for implementation of the first «Seveso» Directive was fixed for 8 January 1984³³.

The Commission has two tasks concerning the control of implementation of Community Law in the Member States. On the one hand, it must verify that Community Directives are correctly and integrally implemented in national laws, regulations and administrative provisions; on the other hand, it must control that the said provisions are concretely implemented by practice.

Regarding the first aspect, art. 226 of the Treaty establishes that the Commission is authorized to initiate a procedure against those Member States which fail to fulfil their obligations. The procedure outlined in the Treaty begins with a letter of formal notice, followed by a reasoned opinion, and finally the issue is brought before the Court of Justice.

The Commission intervened twice in order to denounce infringements related to Directive 82/501/EEC; the first against Spain in 1994. The action against Spain concerned a case of air and water pollution caused by an industrial plant, for which no external emergency plans as set out under art. 8 of the «Seveso» Directive had been provided. This situation constituted not only an infringement of the Directive but also that of the Spanish implementing legislation. Soon afterwards, the Spanish authorities prepared an external emergency plan for the said industrial plant, thus avoiding having the action brought before the Court of Justice by the Commission.

The second time was against Italy in 1997³⁴. In this regard, the Commission had deemed the preparation of emergency measures for action outside the establishments, and the inspections and other control measures inadequate. In particular, the said activities in Italy were considered to be still at the development stage and uncompleted for many industrial activities subject to notification, due to the delay in the implementation of the said Directive. In brief, the actual number of emergency plans provided for and inspections made on the establishments subject to the Directive were considered unsatisfactory. In the end, the Court of Justice of

³² O.J. C 291 of 12 October 1999, pp. 1.

³³ Cf. art. 20 of Directive 82/501/EEC.

³⁴ The application initiating proceedings was lodged at the Registry of the Court on 26 September 1997.

the European Community sentenced Italy for failure to fulfil the obligations set out in the Directive³⁵.

Concerning the second aspect, that is the controls related to the implementation of Community provisions in practice, as stated previously, art. 18 of the original text of Directive 82/501/EEC established that five years after the notification of the Directive, the Commission was obliged to deliver a Report on its implementation to the Council and to the European Parliament, on the basis of the exchange of information among Member States and the Commission.

On 18 May 1988 the Commission produced the first Report³⁶ on the implementation of the «Seveso» Directive by the Member States, where the control of the correct implementation of the Community legislation was divided into three stages.

Firstly, the adoption of specific national legislation for the implementation of the Directive was evaluated; then, the contents of the laws controlling the exact implementation of the contents of the Directive and finally, the concrete implementation of the legislation in practice.

The analysis regarded 10 countries which at that moment of time belonged to the European Economic Community: Belgium, Denmark, France, Greece, Ireland, Italy, Luxembourg, the Netherlands, the Federal Republic of Germany and the United Kingdom.

The Report emphasized that, apart from France³⁷ and Denmark, practically all of the other Member States arrived late for the appointment of 8 January 1984, which was indicated by art. 20 of the Directive as the final date to conform with the contents of the said Directive, and that numerous infringement proceedings were brought against them and later abandoned due to late fulfilment by Member States. For example, no reference was made to Presidential Decree of 1988 in Italy, thus underlining the gaps and delays of our legislative system in conforming to the obligations deriving from the Community Directive.

Afterwards, in order to standardize and rationalize the reports on the implementation of certain Directives relating to the environment³⁸, Directive 91/692/EEC established a procedure for the drafting and formal adoption of a questionnaire which was not completed in time to permit the Commission to produce the first three-yearly report which should have covered the period 1994–1996.

³⁵ Court of Justice of the European Community, 17 June 1999 (case 336/97), *Commission of the European Communities v. Italian Republic*, in RGA, 1999, pp. 841, with note by A. Gratani.

³⁶ COM (88) 261.

³⁷ France already implemented an extensive legislation on “*installations classées*”, therefore implementation by the French government was later carried out by some circulars.

³⁸ In *O.J. L 377* of 31 December 1991, pp. 48–54.

The Committee of Competent Authorities³⁹ in charge of the implementation of the Directive had nevertheless agreed on a questionnaire model, to be used to informally gather information from Member States. According to this questionnaire model⁴⁰, State Members were asked to supply the following information:

- the total number of sites and activities related to the implementation of Directive 82/501/EEC;
- the total number of safety reports already received by the safety authorities, as well as the scheduled total number of the aforesaid;
- the number of safety reports containing internal emergency plans;
- the number of sites which have received a formal request or have been summoned before the Court by the Competent Authorities following examination of the safety reports;
- the number of sites which have an external emergency plan;
- the number of sites which have been inspected by the Competent Authorities; and finally,
- the number of sites which have given information to the public as established in art. 8 of the Directive.

Easy to understand at first sight, the answers to the questionnaire initially offer a global view of the activities and of the establishments taken into consideration by the first «Seveso»⁴¹ Directive, completely lacking a critical review of the problems faced in the implementation of legislation on major-accident hazards.

Nevertheless, it represented an important analysis of Europe made in those years, characterized by the reunification of the two Germanies and by the recent accession of new Member States such as Finland and Sweden.

In a Europe composed of 15⁴² countries in 1996, the establishments subject to the «Seveso» Directive were 3731; 1828 in unified Germany, 430 in Italy, 392 in France, 308 in Great Britain. The number of *safety reports* received by the Competent Authorities were nearly all exhaustive with respect to the number of

³⁹ The *Committee of Competent Authorities* (CCA) shall be composed of the representatives of the Member States and of the Commission services. The Committee shall be chaired by a representative of the Commission and meet once during each chairmanship, that is each semester. The role of the CCA is to effectively implement the provisions of the Seveso Directive throughout the entire Community, cooperating closely with the Competent Authorities of all Member States and of the European Community.

⁴⁰ The questionnaires are found in the Annex to the Report submitted to the Commission in 1999 in Annex I and Annex 2.

⁴¹ An overview of the answers given to the Questionnaire Seveso I in 1996 is inserted in Annex V of the Commission Report, in O.J.C 291 of 12 October 1999, pp. 48.

⁴² Belgium, Denmark, Germany, Greece, Spain, France, Ireland, Italy, Luxembourg, the Netherlands, Austria, Portugal, Finland, Sweden and Great Britain are Member States and answered the questionnaire.

scheduled reports, thus indicating that the fulfilment of the requests made by the Directive was widespread.

Diverse observations could be made in relation to the data gathered on *internal and external emergency plans*⁴³.

Thus, for example, regarding the 430 safety reports gathered in Italy, all of the aforesaid provided for an internal safety plan, but only 84 were deemed acceptable by the Competent Italian Authorities as being adequate, from an administrative point of view, in compliance with the obligations established under art. 7 of the Directive, thus justifying – as previously stated – the intervention by the Commission with a related infringement procedure against Italy.

Regarding the 430 safety reports, 190 provided for an external emergency plan, 179 had been inspected in compliance with art. 7 of the Directive, 319 had furnished information for the public as per art. 8.

Even the 488 safety reports drawn up in Great Britain provided for an internal emergency plan, but 477 were deemed acceptable by the Competent Authorities, indicating a greater precision in fulfilling the obligations set out in the Directive. Of these 488 safety reports, 283 provided for an external emergency plan, 304 had been inspected and 247 had furnished information for the public in compliance with art. 8.

3.3. THE «SEVESO II» DIRECTIVE OF 1996

More than ten years after the «Seveso Directive, the European Community decided to amend once again the entire law governing industrial accidents by adopting Council Directive 96/82/CE of 9 December 1996 '*on the control of major-accident hazards involving dangerous substances*'⁴⁴.

Already in 1994 a proposal for a Directive⁴⁵ had been urged by the fourth action programme for the environment⁴⁶, which had underlined the necessity for a more effective implementation of Directive 82/501/EEC and had called for a review of the said Directive to include a possible extension of its scope, as well as a greater exchange of information on the matter⁴⁷ among Member States.

⁴³ For what concerns France and Germany, the data collected by the questionnaires was incomplete.

⁴⁴ O.J. L 10 of 14 January 1997, pp. 13.

⁴⁵ Council Directive Proposal on the limitation of major-accident hazards related to certain dangerous substances COM/94/4 def, in O.J. C 106 of 14 April 1994 pp. 4.

⁴⁶ The fourth action programme published in 1987 established that the prevention of industrial accidents should be one of the priorities on which the Community policy should focus. O.J.E.C C 328 of 7 December 1987, pp. 1.

⁴⁷ In this sense, the third recital of the aforesaid proposal.

On the other hand, Council Resolution of 16 October 1989⁴⁸ had invited the Commission to study a way to include controls on land-use planning in Directive 82/501/EEC, particularly in light of the consequences of the Bhopal accident and the means of improving reciprocal comprehension and harmonization of national practice principles for safety reports.

Among the reasons which led to a detailed reform of the subject matter were the changes in Community industrial practice in terms of risk management and of the prevention of major accidents, as well as the necessity for substituting Directive 82/501/EEC with more complete and scrupulous provisions, so as to ensure that controls on establishments exposed to the risk of major accidents offered a high level of protection throughout the Community⁴⁹.

The Seveso II Directive thus substituted the original Seveso Directive⁵⁰. The review was not executed as an amendment but as a new Directive, so as to underscore the important changes made and the new concepts introduced by the new regulations.

In particular, these changes regarded the review and extension of the scope, the introduction of new provisions concerning safety management systems, emergency plans and urbanization control, as well as tighter provisions related to inspections made by Member States.

In this regard, the new Directive was introduced in a scenario characterized by new accidents caused by the discharge of dangerous substances by large industrial establishments, which emphasized the danger represented by the proximity of industrial sites to residential areas and the necessity to control land-use planning when authorizing new establishments⁵¹.

The aim of the Second Seveso Directive was twofold; firstly, the prevention of major accidents which involved dangerous substances for man and the environment; and secondly, considering the repeated occurrence of accidents, it was deemed necessary to limit their consequences not only for man, but also for the environment.

The new Directive was introduced following the signing of the Maastricht Treaty in 1992⁵², which gave new momentum to Community action on environment.

Environmental competences were inserted into the Rome Treaty thanks to the Single European Act⁵³ which established three fundamental principles according

⁴⁸ O.J. nr. C 273 of 26 October 1989, pp. 1.

⁴⁹ In this sense, the eighth recital of the proposal, cit.

⁵⁰ Article 23 of Directive 96/82/EC provided for the repeal of Directive 82/501/EEC twenty-four months after the entry into force of the new Directive.

⁵¹ The text of the Directive considered the decisions taken at a community level in order to embrace the needs of a common framework of reference.

⁵² The Maastricht Treaty of 1992 founded the European Union and modified the Rome Treaty of 1957 which had created the European Economic Community, which from this moment on was called the European Community. The Maastricht Treaty entered into force in 1994.

⁵³ Articles 130R-S-T of the European Single Act regulated environmental competences at a Community level for the first time.

to which preventive action should be taken, environmental damage should be rectified at source, and the polluter should pay.

The said competences were successively widened in the Maastricht Treaty, which pursued new objectives such as the promotion at an international level of measures aimed at resolving environmental issues at a regional or global level.

In particular, art. 130R, following the Maastricht Treaty, contemplated that the Community's *environmental policy* should be integrated by other Community policies, such as industrial, agricultural and energy policies, and called on the European Community to adopt all the necessary steps to ensure an effective development and immediate implementation of the aforesaid.

A fourth principle, the precautionary principle⁵⁴, was later added to the three fundamental principles inserted in the Treaty of 1987.

The precautionary principle, which derived from article 15 of the Rio Declaration signed in the occasion of the UN Conference on Environment and Development, established in its original formulation that: *'Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation'*⁵⁵. The said principle, whose contents were later specified in other Community⁵⁶ acts, has become a cornerstone of Community policies on the environment.

The Second «Seveso» Directive introduces a series of innovative aspects, briefly illustrated in the following paragraphs, which underline above all the new priorities set by Community policy on the environment.

With regard to the previous legislation, the Directive of 1996 no longer takes into consideration the specific types of installations, but the presence of dangerous substances, including those classified as *'dangerous for the environment'*, in sufficiently large quantities to create a major-accident hazard, such as a major emission, fire or explosion⁵⁷.

⁵⁴ Art. 130R stated under paragraph 2.: "Community policy on the environment aims at an elevated level of protection, considering the diverse situations in various regions of the Community. It shall be based on the principles that preventive action should be taken, that environmental damage should be as a priority rectified at source and that the polluter should pay..."

⁵⁵ As stated in Principle 15 of the Rio Declaration.

⁵⁶ See Commission statement on the precautionary principle, Brussels, 2 February 2000, COM (2000) 1 def.

⁵⁷ The scope of this Second Directive appears to have been extended with respect to the previous Seveso Directive. In particular, art. 2 of the new Directive now establishes that its provisions shall apply *"to establishments where dangerous substances are present in quantities equal to or in excess of the quantities listed in Annex I, Parts 1 and 2, column 2, with the exception of articles 9, 11 and 13 which shall apply to any establishment where dangerous substances are present in quantities equal to or in excess of the quantities listed in Annex I, Parts 1 and 2, column 3"*. Moreover, the Directive specifies that for *«presence of dangerous substances»* shall mean *"the actual or anticipated presence of such substances in the establishment or the presence of those which it is believed may be generated during loss of control of an industrial chemical process, in quantities equal to or in excess of the thresholds in Parts 1 and 2 of Annex I"*.

Therefore, the scope of the Directive has been extended to include not only the so-called *industrial activities*, but also the storage of dangerous chemicals, where the term *storage* shall mean the presence of a quantity of dangerous substances for the purpose of warehousing, depositing in safe custody or keeping in stock⁵⁸.

This Directive shall not apply to military establishments, installations or storage facilities; hazards created by ionizing radiation; or the transport of dangerous substances and intermediate temporary storage⁵⁹.

The Directive of 1996 establishes general and specific obligations on Member States and the operators. The provisions can be divided into two categories which reflect the two objectives of the Directive: provisions concerning safety measures which aim at preventing major accidents and control measures which, on the contrary, aim at limiting the consequences of the aforesaid once they occur.

In this regard, the Directive specifies that each *operator*⁶⁰, a term which correctly substitutes the word *manufacturer*⁶¹ in the terminology of the new Directive, is obliged to send the Competent Authority a notification containing the characteristics of the installation⁶² and prepare 'a document defining his major-accident *prevention policy* and ensure that it is properly implemented'⁶³.

⁵⁸ As stated in art. 3, item 8) of the Directive.

⁵⁹ The exclusions are indicated in art. 4 of the Directive.

⁶⁰ In accordance with art. 3, item 3 of the new Seveso Directive, the «operator» is "any individual or corporate body who operates or holds an establishment or installation or the individual who has been given decisive economic power in the technical operation thereof, if provided for by national legislation."

⁶¹ Cf. *supra*, what has already been specified regarding the *manufacturer* in Directive 82/501.

⁶² The related terms are specified in art. 6 of the Directive and in particular: for new establishments, a reasonable period of time prior to the start of construction or operation; for existing establishments, one year from the date established under article 24, paragraph 1.

2. The notification required by paragraph 1 shall contain the following details:

- a) the name or trade name of the operator and the full address of the establishment concerned;
- b) the registered office of the operator, with the full address;
- c) the name or position of the person in charge of the establishment, if different from sub a);
- d) information sufficient to identify the dangerous substances or their category;
- e) the quantity and physical form of the dangerous substance or substances involved;
- f) the ongoing activity or proposed activity of the installation of storage facility;
- g) the immediate environment surrounding the establishment (elements liable to cause a major accident or to aggravate the consequences thereof).

3. In the case of existing establishments for which the operator has already provided all the information under paragraph 2 to the Competent Authority, under the requirements of national law at the date of entry into force of this Directive, the notification mentioned in paragraph 1 shall not be required.

4. In the event of any significant increase or significant change in the nature or physical form of the existing dangerous substance, indicated in the notification sent by the operator pursuant to paragraph 2, or any change in the processes employing it, or permanent closure of the installation, the operator shall immediately inform the Competent Authority of the change in the situation.

⁶³ Cf. art. 7 of the Seveso II Directive.

Furthermore, Directive 96/82/CE establishes that operators of establishments that use extremely dangerous substances⁶⁴ are required to prepare a safety report⁶⁵, an emergency plan⁶⁶ and a safety measures programme⁶⁷.

Concerning the *safety report*, the operator shall be required to prove that a major-accident prevention policy and a safety management system for its implementation have been put into effect. In particular, the operator shall have to identify major-accident hazards and adopt the necessary measures to prevent such accidents and to limit their consequences for man and the environment; in addition, the operator shall have to demonstrate that adequate safety and reliability have been incorporated into the design, construction, operation and maintenance of any installation, storage facility, equipment and infrastructure connected with its operation, which are linked to major-accident hazards inside the establishment. The safety report shall also have to demonstrate that internal emergency plans have been drawn up and shall also supply information enabling the external plan to be drawn up in order to take the necessary measures in the event of a major accident. Finally, the operator shall be obliged to provide sufficient information to the Competent Authorities so the latter can make decisions in terms of the location of new activities or factories near existing establishments.

The operator shall be obliged to prepare an *internal emergency plan*⁶⁸ and send it to the Competent Authorities in order to enable the latter to draw up an *external emergency plan*⁶⁹.

Moreover, the Directive of 1996 establishes that the operators need to prepare appropriate safety measures⁷⁰, which correspond to the term used worldwide,

⁶⁴ Those indicated in Annex I, Parts 1 and 2, column 3.

⁶⁵ The safety report shall be subject to the provisions under art. 9 of the Seveso II Directive.

⁶⁶ The emergency plan shall be subject to the provisions under art. 11 of the Seveso II Directive.

⁶⁷ As stated in art. 13 of the Seveso II Directive.

⁶⁸ Art. 11 establishes under sub a) that “the operator shall draw up an internal emergency plan for the measures to be taken inside the establishment:

- for new establishments, prior to commencing operations;
- for existing establishments, not previously covered by Directive 82/501/EEC, within three years from the date indicated in article 24, paragraph 1;
- for other establishments, within two years from the date indicated in article 24, paragraph 1”.

⁶⁹ Art. 11 establishes under sub b) that “the operator shall supply to the Competent Authorities, to enable the latter to draw up external emergency plans, the necessary information within the following periods of time:

- for new establishments, prior to commencing operations;
- for existing establishments, not previously covered by Directive 82/501/EEC, within three years from the date indicated in article 24, paragraph 1;
- for other establishments, within two years from the date indicated in article 24, paragraph 1.”

Finally, the same article establishes under sub c) that “the authorities designated for that purpose by the Member State shall draw up an external emergency plan for the measures to be taken outside the establishment”.

⁷⁰ Cf. art. 13 of Directive 96/82.

Safety Management Systems. The introduction of these measures takes into consideration the development of new organizational and managerial methods and in particular significant changes in industrial practice related to *risk management* which took place in recent years. As a matter of fact, one of the objectives pursued by introducing these measures was to prevent or reduce accidents connected to *managerial factors* which proved to be a significant cause of accidents in more than 90% of the accidents which occurred in the European Union from 1982 onwards.

Another new aspect introduced by Directive 96/82/CE concerned the issue related to the ‘**domino effect**’, which could occur in areas characterized by a strong concentration and interconnection of industries⁷¹. In this regard, art. 8 of the Seveso II Directive states that Member States shall ensure that the Competent Authority, using the information received from the operators, is able to identify establishments or groups of establishments where the likelihood and the possibility or consequences of a major accident may be increased due to the location, the proximity of such establishments and the inventory of dangerous substances used by the latter.

For this purpose, the Member States shall have to verify that the necessary information regarding the establishments thus identified is exchanged in an appropriate manner, on the one hand, in order to enable these establishments to evaluate the nature and extent of the overall hazard of a major accident in the major accident prevention policies, safety management systems, safety reports and internal emergency plans. On the other hand, the Member States must ensure cooperation in informing the public and in supplying information to the Competent Authority for the preparation of external emergency plans.

After the lesson of Bhopal, it was clear that it was necessary to evaluate the implications regarding **land-use planning and control** in order to ensure that industrial activity was compatible with the territorial setting. Even in this regard, the Directive of 1996 introduces a revolutionary change, requiring that Member States ensure that the objectives of preventing major accidents and limiting the consequences of such accidents are taken into account in their land-use policies and/or other relevant policies⁷².

Pursuant to art. 12, Member States shall pursue the said objective through controls on the location of new establishments, modifications to existing establishments or new developments, such as transport links, as well as public and residential areas, when their location might increase the risk or consequences of a major accident. Therefore, Member States shall ensure that their land-use policies take into account the need, in the long term, to maintain appropriate distances

⁷¹ The domino effect shall be subject to the provisions under art.8 of the Directive.

⁷² Cf. art. 12 of Directive 96/82/CE.

between establishments covered by this Directive and residential areas, areas of public use and areas of particular natural sensitivity or interest.

Information has a leading role in the new Seveso Directive, considering that in order to reduce the ‘domino effect’, information must be exchanged in an appropriate manner and provisions must be made for cooperation in informing the public, so that the latter shall dispose of suitable information enabling them to react correctly in similar events⁷³.

Moreover, Directive 96/82/CE emphasizes, with respect to the Seveso I Directive, the importance of public information, which represents a means of prevention and limitation of the related consequences, establishing a series of obligations on the operators, Competent Authorities and Member States.

In the event of a major accident, the operator shall be obliged to immediately inform the Competent Authority, providing details on the circumstances of the accident⁷⁴, the steps envisaged to alleviate the medium- and long-term effects, as well as to prevent any recurrence of such an accident.

The Competent Authority shall be required to ensure that urgent, medium- and long-term measures that may prove necessary are taken, in addition to collecting, by inspection, investigation or other appropriate means, the information necessary for a full analysis of the technical, organizational and managerial aspects of a major accident⁷⁵.

Member States shall ensure that information on safety measures and on the requisite behaviour are given in the event of an accident to persons liable to be affected by a major accident without their having to request it⁷⁶.

On their part, Member States shall be obliged to inform the public and the other Member States potentially affected by major accidents which occur on their territory, as well as the Commission.

Firstly, the Member States shall ensure that information on safety measures and on the requisite behaviour in the event of an accident is supplied, without their having to request it, to persons liable to be affected by a major accident⁷⁷.

Member States shall inform the Commission as soon as possible of major accidents which occurred within their boundaries⁷⁸, providing sufficient information to those Member States potentially affected by the transboundary effects of major

⁷³ Cf. the 18th and 19th recital of the Directive.

⁷⁴ In particular, art. 14 establishes that the operator shall be required to give, as soon as practicable, any information regarding the circumstances of the accident, the dangerous substances involved, the data available for assessing the effects of the accident on man and the environment, as well as the emergency measures taken.

⁷⁵ See art. 14 of Directive 96/82/CE under item 2.

⁷⁶ See art. 13 of Directive 96/82/CE.

⁷⁷ Cf. art. 13 of Directive 96/82/CE.

⁷⁸ Cf. art. 15 of Directive 96/82/CE.

accidents originating in one of the establishments within their boundaries, so that all relevant measures can be taken by the Member State involved⁷⁹.

As already emphasized by the 5th action programme on the environment in 1993⁸⁰, the **participation of the public** must be considered an important factor capable of influencing environmental policies.

Directive 96/82 urges a greater participation of the public in the decision-making process regarding new establishments, by formulating a series of obligations on the Member States.

In particular, art. 13 provides that Member States shall ensure that the public is able to deliver its opinion on plans for new establishments where the risks of a major accident are elevated or modifications to existing establishments or developments surrounding the said existing establishments are introduced.

The *Major-Accident Hazards Bureau* (MAHB) in Ispra is a special unit which gives scientific and technical support to the European Commission for the control of major-accident hazards⁸¹.

As previously stated, Member States are obliged to inform the Commission regarding major accidents occurring in the territory. In this regard, the Commission has created a procedure for the notification and the report of accidents (the so-called Major-Accident Reporting System – MARS) which supplies an important database that handles information at a Community level.

Furthermore, the Office in Ispra supplies guidelines which are useful for the preparation of a series of reports required by the Directive for the implementation of the related obligations⁸², thus playing an important role of intermediary between industries and Member States.

3.4. IMPLEMENTATION OF DIRECTIVE 96/82 IN THE MEMBER STATES AND THE ROLE OF THE COMMISSION

Pursuant to art. 19.4 of the Seveso II Directive, Member States shall provide the Commission with a three-yearly report on the operations carried out by installations where the risks of a major accident are elevated, according to the parameters set out in Directive 91/692/EEC⁸³, that, as already said, standardizes the data to be supplied.

The final date for implementation of the Seveso II Directive was fixed at 3 February 1999.

⁷⁹ Cf. art. 13 item 3 of Directive 96/82/CE.

⁸⁰ O.J. C 138/5 of 17 May 1993.

⁸¹ More information can be found at <http://mahbsrv.jrc.it/>

⁸² Among which: “Guidelines on a Major Accident Prevention Policy and Safety Management System”, “Guidance on the preparation of a Safety Report”, “General Guidance for the content of information to the public”.

⁸³ See *supra*,

Thus, the Commission's Report covering the period 2000–2002 offers some interesting information, it being the first report assessing the progress made with the implementation of the Seveso II Directive.

The Report summarizes the information provided by the Member States on the basis of a Questionnaire⁸⁴ prepared in compliance with the Reporting Standardization Directive which asked the Member States to answer some questions concerning important issues so as to evaluate the actual situation in the single countries, and in particular:

1. the total number of top-tier establishments;
2. the total number of establishments which produced safety reports, in accordance with article 9 of the Directive;
3. internal emergency plans,
4. external emergency plans,
5. the possible domino effect,
6. land-use planning,
7. inspections,
8. any prohibitions regarding operations.

According to the Report, the 15 Member States have fulfilled their obligation pursuant to article 19, paragraph 4 and have provided the Commission with a three-yearly report.

3278 top-tier establishments were reported, that is, approximately one site per 114,000 inhabitants.

The total number of establishments which submitted a **safety report**, in accordance with article 9, to the Competent Authority by 2002 totalled 3057. In other words, 93% of the top-tier establishments had sent their safety report to the Competent Authority.

Pursuant to the Seveso II Directive, the Competent Authorities shall examine the safety reports within a reasonable period of time after receipt of the aforesaid. At the end of 2002, 1334 (43.6%) of the safety reports submitted had been examined.

This relatively low rate can be explained by the fact that, in many cases, the Competent Authorities were overwhelmed by safety reports submitted simultaneously in 2002 for establishments involved for the first time under the Seveso Directive. In addition, the concept of communicated conclusions had been interpreted diversely in different Member States. Some of them, for example Ireland, considered, for statistical purposes, that the conclusions had been communicated only when a final assessment on the safety reports had been made.

The operators of 2983 establishments (91%) prepared an **internal emergency plan** for on-site arrangements and action as required under article 11, paragraph 1.

⁸⁴ O.J. L 120 of 8 May 1999, pp. 43.

According to article 9, the safety report shall demonstrate that an internal emergency plan has been drawn up. In practice, the internal emergency plan is sent as a part of or annex to the safety report. Therefore, the existence of an internal emergency plan shall be known only after the safety report has been received.

However, the reported number of existing internal emergency plans was higher than the number of submitted safety reports, as some Member States reported that all establishments had internal emergency plans, although not all operators had submitted their safety report. In these cases, the Competent Authorities had assumed the existence of the internal emergency plans.

The Competent Authorities prepared **external emergency plans** for 1129 establishments (34.4%). An external emergency plan contains the off-site arrangements, procedures and actions.

The figures provided by the Member States indicate that many top-tier establishments were operating, by the end of 2002, without proper external emergency plans. The external emergency plans are key elements, for prevention and accident control purposes, in order to minimize the effects and limit damage to man, the environment and property.

In view of the importance that these external emergency plans have in the context of limiting the off-site effects of accidents, Member States were invited to give additional information that could explain the delays in drawing up these external emergency plans.

In general, Member States explained that one of the reasons was due to the late and simultaneous reception of the safety reports, as the said reports contain the information needed to draw up the external plans. Member States also indicated that, in most cases, such plans already existed by the end of 2002, but had not been sent because they existed as a draft or had been drawn up according to the Seveso I Directive criteria.

Member States have recognized the need to rapidly improve the situation with regards to the drawing up of external emergency plans.

The **information to the public**, as referred to in article 13, paragraph 1, was issued for 2090 top-tier establishments (63.8%).

Article 13 foresees that Member States shall ensure that information on safety measures and the requisite behaviour in the event of an accident is supplied, without their having to request it, to persons liable to be affected by a major accident originating in an establishment as per article 9.

Article 13 also states that the maximum period between the repetitions of the information to the public shall, in any case, be no longer than five years.

Therefore, in theory, persons that had been properly informed in 1998 or 1999, for example, regarding establishments already contemplated by the Seveso I Directive, would not necessarily have needed further information on safety measures during the period 2000–2001.

The supplied figures indicate that in a significant number of cases (36.2% of the top-tier establishments), no active information was given to the public, and it is unlikely that all these establishments corresponded to establishments previously covered by the Seveso I Directive and for which the provisions related to public information had been fulfilled in 1998 and 1999.

With regard to **inspections**, in 2002, 2163 top-tier establishments (66%) were inspected, as referred to in article 18, paragraph 1.

Article 18, paragraph 2 states that an on-site inspection should in principle be carried out at least every 12 months or be based on a systematic appraisal of major-accident hazards in that particular establishment.

As a result, all top-tier establishments shall be inspected once a year, unless the Competent Authority has established a programme of inspections base upon a systematic appraisal. Considering their hazard potential, some establishments may be subject to two or more inspections in certain years, with respect to other establishments.

In conclusion, it is important to mention that reporting is not only a source of information, but also an important tool to monitor the progress made by the practical implementation of a directive. For example, the data submitted during the period 2000–2002 enabled the Commission to highlight some strengths and weaknesses in the practical implementation of the Directive.

The monitoring of progress made with the practical implementation is complementary to the transposition check carried out by the Commission on the basis of notified legislation.

In this regard, art. 226 of the Treaty establishes that the Commission has the authorization to initiate infringement proceedings against Member States that fail to fulfil their obligations. In this sense, having failed to adopt the necessary measures to comply with the provisions under art. 11 of the Directive, the Federal Republic of Germany was summoned before the Court of Justice and sentenced⁸⁵.

3.5. THE TOULOUSE ACCIDENT AND THE NEW AMENDMENTS MADE TO THE SEVESO II DIRECTIVE

On 21 September 2001, the explosion at the Azf establishments in Toulouse, killing thirty and seriously injuring hundreds of people, resumed the debate regarding the legislative framework concerning environmental and industrial risks.

The European Parliament passed a Resolution on 3 October 2001, which invited the European Commission to publish, within three months, a list of sites inside the boundaries of the Union which, in the event of an accident, could cause serious damage similar to that which occurred in Toulouse.

⁸⁵ European Community Commission v. the Federal Republic of Germany Collection 2002, pp. I-4219.

The intent was to take full account of the lessons learned from this tragedy, by urging the Commission to review the Seveso II Directive, on the basis of the following elements:

1. strengthening safety and control standards in order to prevent major accidents and limit the consequences for man and the environment;
2. extension of the scope of the Directive;
3. lowering the limits for industrial discharges into the water and the atmosphere;
4. extension of security parameters, including retroactively;
5. improved information to the public on the risks faced and the measures to be taken in the event of a disaster;
6. organisation of epidemiological studies in areas close to dangerous establishments;
7. strengthening of the role of health and safety committees in enterprises involved, and more attention given to the opinion of employees and trade union organizations.

On 10 December of the same year, the Commission submitted a Proposal for a Directive aiming at amending the previous Directive of 1996, published later in March 2002⁸⁶, which mentioned two accidents which occurred at Baia Mare in Romania and at Enschede in the Netherlands, demonstrating that certain storage and processing activities in mining, as well as storage and manufacture of pyrotechnic and explosive substances, have the potential to produce very serious consequences for man and the environment, thus intending to extend the scope of Directive 96/82/CE.

At the same time, even in the sixth action programme on the environment⁸⁷ covering the period 2001–2010, a review of the Seveso Directive was provided for and the Community indicated among its objectives the ‘necessity to adopt a coherent and consolidated policy in order to face natural catastrophes and accident risks’.

In this context, the Seveso II Directive alone offered a valid base for the management of industrial risks, but at the same time it was acknowledged that it ‘*needed to be extended to include the exploitation (exploration, extraction and processing) of minerals, including hydrocarbons*’.

Thus, the action programme already considered how to ‘extend the Seveso II Directive in order to include the exploitation (exploration, extraction and processing) of minerals, including hydrocarbons and related measures for waste management’.

⁸⁶ See the Proposal in O.J. C E/357 of 26 March 2002.

⁸⁷ Commission’s Communication to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions on the sixth action programme on the environment of the European Community “*Ambiente 2010: il nostro futuro, la nostra scelta*” - Sesto programma di azione per l’ambiente, COM/2001/31 def.

3.6. CHANGES INTRODUCED BY DIRECTIVE 2003/105

On 31 December 2003, Directive 2003/105/EC was introduced, amending Council Directive 96/82/EC on the control of major-accident hazards involving dangerous substances.

As stated in the second recital, the Directive aims at extending the scope of Directive 96/82 in the light of recent industrial accidents and studies on carcinogens and substances dangerous for the environment carried out by the Commission at the Council's request.

The extension covered by the new Directive involves:

1. the exploitation (exploration, extraction and processing) of minerals in mines, quarries, or by means of boreholes, with the exception of chemical and thermal processing operations and storage related to those operations which involve dangerous substances, as defined in Annex I;
2. operational tailings disposal facilities, including tailing ponds or dams, containing dangerous substances as defined in Annex I, in particular when used in connection with the chemical and thermal processing of minerals⁸⁸.

Particular attention is given to the territorial aspect, where current regulations provide that Member States are obliged to scrutinize their land-use and related policies as well as the procedures for implementing those policies, to ensure that they take account of the need, in the long term, to maintain appropriate distances between establishments covered by this Directive, on the one hand, and residential areas, buildings and areas of public use, major transport routes, as far as possible, recreational areas and areas of particular natural sensitivity or interest, on the other hand⁸⁹.

Importance is also given to information on safety measures and on the requisite behaviour in the event of an accident, which must be supplied regularly and in the most appropriate form, without their having to request it, to all persons and establishments serving the public (such as schools and hospitals) liable to be affected by a major accident originating in one of the establishments covered by article 9⁹⁰.

In conclusion, the Directive also establishes that Member States shall bring into force the laws, regulations and administrative provisions necessary to comply with this Directive before 1 July 2005.

⁸⁸ As stated in art. 1 of Directive 2003/105.

⁸⁹ Pursuant to the new art. 12.

⁹⁰ As stated in the amended art. 13.

3.7. THE CURRENT SITUATION IN AN ENLARGED EUROPE: SOME INITIAL CONSIDERATIONS ON THE IMPLEMENTATION OF REGULATIONS INVOLVING MAJOR ACCIDENTS IN THE TEN NEW MEMBER STATES

On 1 May 2004, ten new countries joined the European Union.

The European Union had already considered the Enlargement of the Union in the policies formulated in the Sixth action programme on the environment, by emphasizing how the new Member States would have changed the European Union's profile during the period covered by the programme: the enlargement from the current 15 to approximately 25 countries would have involved an additional 140 million inhabitants, a significant extension of the territory, as well as problems concerning the environment and unique national heritages.

In the ten new countries belonging to Central and Eastern Europe, the situation regarding the environment appeared to be diverse: many rural areas are still intact, with entire areas covered by centuries-old forests; agriculture tends to be extensive and encourages a rich biodiversity. On the other hand, there are many industrial centres or former military bases which are heavy polluters and require substantial investment in anti-pollution projects.

The European Union had considered that a successful implementation of Community regulations on the environment and human health should have been the responsibility of each Candidate country. In order to lead this process and ensure, in the course of time, full implementation of the environmental '*acquis*' by Candidate countries, the said '*acquis*' needed to be implemented in each national legal system at the moment of joining the EU.

On their part, the Candidate Countries had demonstrated their good intentions by joining the European Environment Agency before joining the European Union. In this regard, the Commission reformulated the data in order to evaluate the implementation of the Seveso Directive in the various Member States.

The next report, covering the period 2003–2005, shall concern the successful implementation of the Seveso Directive, taking into account the changes and the different situations existing in the 10 new Member States which contributed to its drafting.

In this period of time, however, the Commission started evaluating the implementation of the Seveso II Directive in the 10 new Member Countries, by sending a specific questionnaire on the implementation of the said provisions.

The answers to the questionnaire supplied important information on the situation existing in the 10 new Member States up to the end of 2003. In particular, the said information regarded external emergency plans, as well as land-use and urban impact, public information and inspections in all of the 10 new Member States including Bulgaria.

With respect to these 11 legal systems, the so-called top-tier establishments totalled 434, 146 of which are in Poland, 74 in the Czech Republic, 46 in Hungary, 38 in Slovakia and 35 in Bulgaria.

With regard to safety reports, the results still appear to be diverse, considering that 134 out of 146 Polish establishments produced a safety report, 72 out of 74 Czech establishments produced a safety report and 100% of the Hungarian establishments did the same. No report was submitted by the Slovak Republic nor by Bulgaria.

Nevertheless, the single legal systems were given different due dates and thus the Member States which joined on 1 May 2004 produced their safety reports according to the following three timetables:

1. The Czech Republic, Poland, Hungary and Latvia, with due dates set at the end of 2003, submitted the majority of these safety reports before the said date.
2. Estonia, Slovenia and Malta, respectively having due dates in January, May and July 2004, submitted their safety reports by the end of 2004.
3. Cyprus, Lithuania and the Slovak Republic, with due dates set at mid-2005, were unable to submit any report in 2004.

Regarding **internal emergency** plans, the figures reflect what was said in terms of safety reports, except for Estonia, which had submitted its safety reports in advance at a national level. Therefore, Hungary and Lithuania had submitted 100% of the said plans, followed by Poland (22%) and the Czech Republic (18%).

Concerning **external emergency** plans, the figures are more or less similar: Hungary and Lithuania submitted 100% of the said plans, Estonia 80%, followed by Poland (22%) and the Czech Republic (18%).

The Report indicates that all top-tier establishments in Cyprus, Hungary and Poland were inspected in 2003. The said report stated that the number of inspections in the Czech Republic and in Estonia would have increased during 2004. Slovenia and the Slovak Republic supplied data regarding the period 2004 and 2005, declaring that in the said period all establishments would have been subject to inspection.

Malta was the only country unable to forecast how many establishments would have been inspected in the years to come.

With regard to lower tier establishments, Cyprus, Hungary, Latvia and Lithuania declared that 100% of their establishments had been inspected. Estonia declared 80%, Poland 65% and the Czech Republic 42%.

In conclusion, all new Member States, including Bulgaria, were able to answer the questionnaire in a short period of time. The amount of data supplied demonstrates the rapid improvement in the implementation of the Seveso II Directive.

Even the information supplied by the new Member States concerning information strategy, inspections and land-use is very important.

The answers sent by the new Member States demonstrate that the operators of establishments had sent the notification to the Competent Authority in 2002 or at the beginning of 2003, containing information on the quantities of dangerous substances in the establishments and enabling the identification of the so-called top-tier establishments.

The operators of the aforesaid establishments shall draw up safety reports and internal emergency plans. The said process has been carried out by four new Member States, while another three are in the progress of doing the same. The remaining three countries (Cyprus, Lithuania and the Slovak Republic) are obliged to meet the deadline in 2005.

In addition, the safety reports shall contain internal emergency plans with sufficient information to allow the Competent Authority to prepare external emergency plans. The said process appears to have been carried out in Estonia, Hungary and Lithuania.

4. Transportation

The international carriage of dangerous goods has long been governed by established international agreements known, in the case of land transport, by the abbreviations ADR (for road transport), RID (rail) or ADN (inland waterways). These rules were drawn up by international organizations that have a wealth of experience and knowledge in the field. They are updated at intervals to keep pace with technical progress and improve safety.

The European Union's approach is to issue these rules via specific directives which are then made applicable to national transport too, not just transport between Member States.

After the adoption of the new framework Directive on the inland transport of dangerous goods (2008/68/EC of 24 September 2008), the legislation in the European Union covers road, rail and inland waterways under one unified Directive.

In the context of its global goal of improving safety in transport, the European Union issued in 1999 the Directive 1999/36/EC⁹¹ to enhance safety with regard to transportable pressure equipment approved for the inland transport of dangerous goods by road and by rail. The Directive aims simultaneously to ensure the free movement of such equipment within the Community, including the placing on the market and repeated putting into service and repeated use aspects.

⁹¹ Council Directive 1999/36/EC of 29 April 1999 on transportable pressure equipment, in Official Journal, 1 June 1999, L 138.

5. Liability for Harm Caused by Dangerous Substances

Environmental law is a relatively recent field from the juridical point of view, and it is not surprising that it is in continuous evolution stimulated by new needs, awareness and technology. However, along with these basic dynamic factors there are others related to the more refined juridical considerations which deal with the needs, awareness and technological changes, and therefore select new instruments and understand more clearly the pattern of their interaction. Starting from the 1980s we find, in the more advanced juridical systems, a tendency which has been acquiring approval and depth through the years and has marked the beginning of current environmental law. This tendency is characterized by the recovery, within the juridical instruments, of environmental protection of tort liability which is a long neglected institution in favour of purely public law instruments.

For an idea of the extent of this phenomenon, let us examine the relative legislation:

- in 1980 the US Congress passed the Comprehensive Environmental Response Compensation and Liability Act.
- in 1983 the Swiss Confederation adopted the *Federal Law for Environmental Protection*.
- on July 8th, 1986 Italy approved Law 8 no. 349 – The Institution of the Environmental Ministry and regulations for matters of environmental damage.
- on April 7th, 1987 Portugal formulated *The Basic Environmental Law*.
- on January 1st, 1991– from Germany the *Umwelthaftungsgesetz*.

Let us remember that tort liability, before appearing in the internal legislation of single nations, was the subject of numerous International Conventions focusing on environmental protection, such as:

- on tort liability in the nuclear field, signed in Paris on July 29th, 1960.
- regarding the emission of hydrocarbons, signed in Brussels on November 29th, 1969.
- for the international responsibility of nations for objects launched into outer space, signed on March 29th, 1972.

We can find the same tendency in numerous international documents, such as the *Green Book* of the European Union or the *Lugano Convention* of 1993 and the *White Paper on Environmental Liability* presented by the Commission in February 2000⁹² where the validity of this instrument in the environmental field is argumentatively emphasized. When we examine these sources we notice the

⁹² *White Paper on Environmental Liability*, presented by the Commission of the European Communities, Brussels, 9 February 2000, COM (2000) 66 final.

tendency of modern legislatures to adopt a criterion of strict liability⁹³. In the debate on introducing a specific type of responsibility, the insurance problem has always been an important factor. We can note the tendency of modern environmental legislation to make insurance compulsory, especially for those companies whose activities could be particularly dangerous for the environment⁹⁴.

The *Green Paper* of the European Community points out how tort liability is inevitably related to the problem of insurability because insurance should be considered a means of controlling the risk of an economic loss⁹⁵. This document of the Commission recognizes insurance as an important means of compensation in cases where there is accidental damage and where the expenses for restoration are covered by the insurance policy.

The *Green Paper* on remedying environmental damage of 1993 was followed by the *White Paper* on Environmental Liability published in February 2000, whose purpose was to examine how the 'polluter pays principle' could be applied with a view to implementing Community environment policy.

The conclusion was that a Directive would be the best way to establish a Community environmental liability scheme.

Finally, after a public consultation period held after publication of the White Paper, the Environmental Liability Directive (ELD) was enacted in April 2004⁹⁶.

Directive 2004/35/EC (ELD) establishes a framework based on the 'polluter pays' principle, according to which the polluter pays when environmental damage occurs.

This principle is already set out in the Treaty establishing the European Community (Article 174(2) TEC). As the ELD deals with the 'pure ecological damage', it is based on the powers and duties of public authorities ('administrative approach') as distinct from a civil liability system which is more appropriate for 'traditional damage' (damage to property, economic loss, personal injury).

The Directive's main objective is to prevent and remedy 'environmental damage'. Environmental damage is defined as:

⁹³ On the problem of the criterion for accusations of liability, may I refer to POZZO, "Il criterio di imputazione della responsabilità per danno all'ambiente nelle recenti leggi ecologiche", in *Per una riforma della responsabilità civile per danno all'ambiente*, (translation: The criterion for accusations of liability for environmental damages in the recent ecological laws in For a reform in tort liability for environmental damage) edited by Pietro Trimarchi, IPA-Giuffrè, Milano, 1994; cf. also COUSY, *Évolution comparée des droits européens de la responsabilité*, in *Risques*, No. 10, avril-juin 1992, p. 41.

⁹⁴ American legislation makes insurance obligatory by the CERCLA (*Comprehensive Environmental Response Compensation and Liability Act*) of 1980 and the German one, *Umwelthaftungsgesetz* of 1991.

⁹⁵ See point 2.1.11 of the introduction of the *Green Book*.

⁹⁶ Directive 2004/35/EC of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage, in *Official Journal* 30 April 2004, L 143.

- damage to protected species and habitats (nature),
- damage to water,
- damage to soil.

The liable party is in principle the ‘operator’, i.e. the one (natural or legal person) who carries out an occupational activity. The operator, who carries out certain dangerous activities as listed in the Directive, is strictly liable (without fault) for the environmental damage he caused. He might, though, benefit from certain exceptions and defences allowed by the ELD (for example *force majeure*, armed conflict, third party intervention) or by transposing legislation of the Member States (for example regulatory compliance defence, state of the art defence).

All operators carrying out occupational activities are liable for fault-based damage they cause to nature as defined by the ELD.

Operators have to take the necessary preventive action in case of immediate threat of environmental damage. They are equally under the obligation to remedy the environmental damage once it has occurred (‘polluter pays’). In specific cases where the operators fail to do so or are not identifiable, the competent authority may step in and carry out the necessary preventive or remedial measures. Remediation has to consist basically in the restoration of the damaged natural resources (nature, water, soil) either in kind or by recreation of similar resources.

The ELD leaves significant discretion to the Member States, which may not only decide on the use of optional defences but also on other optional choices (scope regarding damage to nature, as regards the ‘operator’-definition, the type of multi-party causation, the forms and measures regarding financial security, etc.), and may moreover take or maintain stricter measures than prescribed by the Directive (Article 176 TEC, Article 16(1) ELD). This characterizes the ELD as so-called *framework* directive.

Civil society plays an important part when it comes to necessary preventive and remedial action: Affected natural or legal persons including environmental NGOs have the right to request the competent authority for action if they deem it necessary. If the entitled persons consider that the competent authority, which has to inform them about the decision to accede or to refuse the request for action, has failed to take the appropriate decision, they even have the right to appeal before a court or other independent public body to review the decision.

The Environmental Liability Directive entered into force on 30 April 2004. The EU Member States had three years to transpose the Directive in domestic law. Up to mid November 2008 only two thirds of the Member States have fully transposed the ELD. Against those Member States who fail to transpose the ELD, the Commission has initiated infringement procedures in June 2007 which entered the stage of Court application in early summer 2008.

The Commission has to report by April 2010 on the effectiveness of the Directive in terms of actual remediation of environmental damages and on the

availability at reasonable costs and on conditions of insurance and other types of financial security.

6. Some Conclusions on the Effectiveness of Environmental Law

The environment being a so-called *global common*, environmental law has developed rules at various levels: international, supranational (EU) and national level. That is to say it has a multi-level organization.

Scholars often point out the difficult question concerning the search for the optimal level of the rule in terms of protection of the environment: where do we achieve the best result? At international, European (supranational or federal) or national level?

We also have to bear in mind the particular character of this legislation, that includes rules with a high technical content that are generally well accepted even in countries with a very different legal background. That is why we can find common patterns all over the world: in Europe and in the US as well as in India.

The phenomenon is known as ‘legal transplants’, which very often happen in the case of rules with a high technical content, because they do not involve impact on fundamental values of the particular legal system.

Real differences emerge in the approach, as well as in the implementation process.

Differences in the approach may depend on the sharing of background principles – for example, in the understanding of the precautionary principle – that often oppose American scholars to European scholars; or in the application of the principle of the information and participation of the population, that may differ from country to country even inside the EU member States.

Other important differences may arise in the implementation of environmental law, where we have to distinguish the *law in the books* from the *law in action*. In fact, distortions in its efficient application may derive from the different understanding of background values, from inefficient sanctions (lack of monitoring, restrictions on budget), from the machinery of justice that might end up in providing inadequate tools to implement the law.

That is why scholars as well as Supreme Jurisdictions have pointed out that monitoring the application of environmental law is even more important than the actual content of the rule itself.

The Supreme Court of India has in recent times pointed out: ‘If the mere enactment of laws relating to the protection of environment was to ensure a clean and pollution free environment, then India would perhaps be the least polluted country in the world’⁹⁷.

⁹⁷ Indian Council for Enviro-Legal Action v. Union of India, 1996

TERRITORIAL VULNERABILITY IN SAFETY AND SECURITY

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Abstract This contribution mainly refers to the safety and security vulnerabilities of a territory during and after a period of crisis, social development, state building, economic recovery and political changes. The challenges to be faced are not the single threats that security forces used to cope with, but their combination, and overlapping. The territory itself has lost most of its geographical meaning and is transformed in ‘environment’, implying the need to include the criminal threat against our living space and resources among the social, political and economic threats to safety and security. Such a combination of threats requires a new international cooperation and a better integration of military and non-military security resources.

1. ‘Krisis’ as Transition

The terms ‘crisis’, ‘safety’, ‘security’ and ‘territory’ are well known: the territory is an area subject to the sovereignty of a state, crisis is ‘an unstable condition involving an impending abrupt or decisive change’; safety is the ‘freedom from danger, risk and injury’, while security has the same meaning, but referred to the prevention of attacks, sabotage or espionage, turmoil, crime and violence. Safety and security are both connected to the wellbeing of the individuals and the institutions. That is why they are paramount duties of the government, which has sole responsibility for public safety and security. In spite of the simplicity of the definitions, the meaning of the terms has greatly changed in the last 20 years. In our globalized world the territory of our safety and security is not our own state territory anymore. We are all exposed to safety threats coming from neighbouring countries and even from far away regions. How a state exploits nuclear power, chemical plants, natural resources, inner and outer space, affects everybody’s safety and security. How a state produces, stocks, trades and allows the transfer of hazardous materials, what kind of transportation, what kind of trade control, what kind of end users, and what kind of preventive measures against accidents or against deliberate attacks it adopts, are a matter of international concern. The

'control of the territory' has therefore become wider and much more complex, requiring international coordination and cooperation between governments, safety organizations and security forces (both police and military). If the control of the territory is difficult in stabilized areas and well-structured states, one can imagine how difficult it is to deal with public safety and security during and after the periods of crisis whose meaning has changed as well. As a matter of fact, 'Crisis' is no longer a turning point, but a long negative situation where political sovereignty is weak or put under pressure by internal and international demands.

The political primacy of dealing with safety and security is unquestioned, but such primacy does not automatically exclude or limit the responsibility of the safety organizations and the security forces to guarantee that the political and administrative authorities enjoy the kind of safe and secure environment (SASE) necessary to stabilize a crisis area. The smooth transition from a foggy and unstable situation to a new and better one is the most serious challenge of modern times. The Greek word for 'passage' or transition is 'Krisis' and the government that has the responsibility to get through it is a 'crisis manager' by definition. It has to face many challenges, and the main vulnerabilities are not only those created by war, humanitarian disaster, economic collapse or devastation, but also those created by the vacuum of authority, the lack of rules or by their incompatibility with the rules of the neighbouring countries. In many areas of the latest conflicts and transitions, the delay in establishing legitimate, fair and effective government has given space to ethnic retaliation, revenge, crime, extremism and even terrorism. Furthermore, many transitional areas received a lot of resources, money and solidarity while others, less turbulent but not less important, were left alone. The resources poured into turbulent areas are huge.

For example, the NATO 78 day bombing campaign on Serbia and Kosovo cost \$8 billion. International accountable money poured into Kosovo reached in 2004 the total of \$9 billion (source UNDP) plus an unidentified unaccountable sum from private donors, Albanian Diaspora, and other more or less transparent 'fundraising' activities. This flow should be added to the indirect money coming from 11,000 employees enrolled by the United Nations and by the half million soldiers of 40 different countries that rotated since 1999 in a small area of 10,000 square kilometres and who lived in 117 military installations. The resources made suddenly available to the turbulent areas function as 'attractors' of any kind of 'investment' and they fuel expectations both in the local population and mafias. It has been held in academic forums that in such a situation the social and cultural environment will only improve through comprehensive projects and redundancy of financial efforts, helping democracy and institution building. Giovanni Falcone, the Italian judge who fought against the Sicilian Mafia, did not share this view. He said that economic development does not always curb the criminal perspectives. On the contrary, in a weak and vulnerable social environment the more money is available, the more the investing projects are fragmented, and the more the

criminal activities will profit and grow. He had to be right because the Mafia used 6 tons of explosive and destroyed an entire highway in order to kill him, his wife and his bodyguards.

The money flow into crisis areas is usually handled by 'Key facilitators' like politicians, entrepreneurs, traders, former fighters, national and international administrators and by the so-called 'untouchables' who deal with licit and illicit businesses while enjoying power and impunity. On the other hand, the neighbouring areas, often poor as well, do not enjoy the same benefits but are equally exposed to criminal risks and political instability.

2. The Nature and Shape of the Threat

The threats that these areas have to face are of a military nature only with regard to the possibility that neighbouring countries or organized groups of rebels decide to attack or destabilize the local government. This event has been proven to have very low probability in the Balkans and medium to low probability in other areas of Eastern Europe. Therefore the most severe shortfalls that hamper smooth transition and development are not in the military security realm (even though they could adversely affect it at any time).

They are in the dramatic economic situation, in the inconclusive political debate over issues of little practical importance, in the inefficient administrative system both local and international, in the United Nation's loss of credibility, in the subversive struggle for power, in the political corruption, in the institutional inability to face the real problems, and in the constant manipulation of historical and past events for ambiguous and often criminal purposes. A crisis area is therefore a realm of uncertainty, insecurity and huge safety risks, because a territory without authority and out of control is a time bomb ready to explode. The safety risk is coming both from the internal sources of hazardous materials legally produced and from the transit through the crisis area of materials legally produced abroad or illegally produced and shipped. A country without a tight control over the sources of production and short in financial means to handle properly the hazardous material is put in a situation of higher safety risk. A country left in the hands of mafias and traffickers does not even know what is going on and what kind of risk she is taking. A country that is considered weak can become the target of deliberate attacks that in the modern asymmetric fight will aim at destroying sensitive targets or at damaging the natural environment using explosives, but also chemical, biological, radiological and dangerous waste devices (dirty bombs). Here the security risks are in proportion to the safety problems and to the disaster prevention and relief measures. Here, safety and security are connected both to external and internal threats and to destabilization, corruption and criminal forces.

Threats to security take the shape of extremism, terrorism, inter-ethnic and intra-ethnic violence, destabilization, crime, corruption, trafficking, assumption of power by clans and mafias. Each form is very complex and difficult to detect and challenge. However, any one of them is not as dangerous as their combination. Every nation is somehow prepared to face each challenge, but no nation is equipped and ready to fight them all at the same time. Nevertheless, this is exactly what a nation should prepare for, because the major threat the world must cope with is the overlapping of these single threats.

Western and Eastern European countries show a very high degree of overlapping, especially between politics and crime, law enforcement and crime, legal and illegal activities, public and private interests, local and global reach, legitimate governments and private or illicit organizations, solidarity and greediness, development and speculation, solidarity and exploitation.

Without a series of coordinated political and security actions it is almost impossible to isolate one form from the others, and their combination and complementarities have the potential to divert entire regions from their path to freedom, democracy and stability.

The most profitable fields of threat combination are the production and trafficking of drugs, human beings, commodities and hazardous materials, and urban and toxic waste.

Drugs like cocaine, heroin and synthetic stimulants see Western Europe as a target and Eastern countries as main transit areas. The major source of opium and drugs is Afghanistan, from where two main routes across Central Asia, Eastern Europe and the Balkans reach the addict markets of the West. Afghanistan is the world leading producer of opium, and the country hosts 80,000 thousand foreign troops and 150,000 local security forces. This is not typical of Afghanistan.

The worldwide illicit traffickings converge on five points of the planet (Gulf of Mexico and Caribbean, Mediterranean Sea, South China Sea, Gulf of Nigeria and Afghanistan). The trafficking gets therefore easily and steadily through the 'militarized arc' where 90% of military and security forces of the world are deployed. This arc also contains major resources, strategic lines of communications, terrorism attacks and wars. In Afghanistan, as in other troubled areas, it seems that drug production and instability increase with the growth of security forces; Afghanistan is still at the top of the Failed States index.

Human trafficking is another field of overlapping threats originating mainly in Eastern Europe and reaching the West. The routes of prostitution follow an interesting itinerary made up of voluntary migration, abduction, corruption and personal violence. Prostitution is big business for all European mafias. Most prostitutes come from Eastern Europe and after a sort of 'training', grooming and 'in-processing' in staging areas like the Balkans they are re-directed to Italy, Europe and beyond. Many of them are also re-directed to the Middle and Far East, establishing a new kind of slavery route. Stolen cars, like other commodities, cross

Europe back and forth, and in many cases they are used in payment for other forms of illegal trafficking. In the West someone invented the 'oil for food' or 'weapons for food' programmes, while the mafias have a long experience of 'drug for cars', 'girls for contracts' and 'weapons for diamonds and gold'.

These overlapping threats may appear of security interest, but not of safety concern. This is a wrong perception because these threats undermine the capability of territorial control and the capability of safety organizations to prevent and monitor the trafficking of hazardous materials, which has become a huge source of money for criminals, and not only for them.

The safety risk related to hazardous material and other security risks should be defined in probability terms and not in terms of possibility. Nowadays almost everything is possible, but a risk, in order to be prevented and dealt with, must be defined in terms of probability and assessable damage. The formula of Risk is $R = P_{ev} \text{ (Event Probability=threat)} \times P_d \text{ (Probability of Damage=vulnerability)} \times D \text{ (damage)}$. In the case of natural disasters the Probability of the event is not affected by the vulnerability of the target and by the type or size of damage. The event will occur following a statistical pattern or a chaotic pattern. In the case of accident, the probability of the event will be affected by the vulnerability of the target (lack of maintenance, lack of control, lack of safety precautions, etc.), but not by the type of damage, which will be a mere consequence.

In the case of deliberate attack (terrorist or saboteur) and deliberate crime against hazardous facilities or using hazardous materials, the probability of the event is affected by the vulnerability of the target/system and by the kind of effect that the terrorist or the criminal wants. The terrorist wants to destroy and kill and the criminal wants to make money out of the damage. Both are disruptive for the entire system. We have to be very vigilant toward the use of hazardous material by the terrorists. However, the probability is very low because the statistics are almost irrelevant. Terrorist attacks have decreased in the last twenty years and the absolute majority of attacks have used conventional explosives. The known attack of Aum Shiryukyo in Tokyo using Sarin toxic is an exception that took place in a very naïve way after years of failed attempts to get the chemical from regular states and even from rogue states. However, a deliberate criminal attack is far more probable because the statistics are accurate and show an increase.

In fact, the best emerging market of illicit traffic is related to the production and disposal of urban waste, hazardous waste and toxic waste. In many under-developed areas the production of hazardous material is out of control and mainly run by profiteers. In other turbulent areas the production was stopped, but not the trafficking or the illegal disposal of dangerous waste. The area of Mitrovica in Kosovo and the Trepca industrial complex have not yet resumed a decent production, but NATO forces had to witness the disappearance of huge amounts of lead and zinc concentrate that had to be sold or transferred. The electrolytic zinc plant was sabotaged in 2000 and became a source of huge land and water

pollution. The concentrated minerals were not protected, and without appropriate containers they were released into the ground and in the Ibar River under the eyes of United Nation officials.

The new pirates that nowadays threaten cargo vessels look for a ransom, and from time to time we see military ships going after them. What we do not see is that in many cases the cargo commanders prefer to pay ransoms in order not to disclose what they transport. And we all know that failed countries like Somalia are invaded by toxic waste and that many cargos disappear in the Mediterranean or the Red Sea, with no sign of accident or disaster.

What happens in normal and democratic countries is not much better at all. Last year the Italian authorities investigated a mafia clan accused of trafficking nuclear waste and trying to make plutonium. The 'Ndrangheta mafia is alleged to have made illegal shipments of radioactive waste to Somalia, as well as seeking the 'clandestine production' of other nuclear material. Two of the Calabrian clan's members are being investigated, along with eight former employees of the state energy research agency. The eight are suspected of paying the mobsters to take waste off their hands in the 1980s and 1990s. The investigating judge warned that Europe's police forces were 'unequipped' to take on the mafia, whether the 'Ndrangheta, Naples' Camorra, or Sicily's Cosa Nostra. He said: 'The mafias were the first to take advantage of Europe's disappearing frontiers, but when I go to Germany I see they have not introduced the crime of mafia association and do not allow wire taps in public places. I'm tired of round tables and conventions; what we need is more courage.' Many other turbulent areas and failed states have become sites of toxic and non-toxic waste shipped from all over the world. The industrialized countries produce nearly 80% of the total urban waste generated annually in the world, and they export 10% of that proportion, for the most part to underdeveloped countries in dire economic straits. For years, Latin America, and in particular southern countries like Paraguay or Argentina, was used by industrialized countries as a garbage dump. Argentina is also the final destination of Australian nuclear waste.

It has been discovered that the international mafias lead two connected but separately managed illicit markets, one for urban waste, and one for hazardous waste. The illicit market for handling urban waste is said to have developed in some southern Italian provinces where 'mafia-type organizations are the main intermediaries for contracts offered by local administrations'. The even more lucrative market for hazardous waste management, in contrast, is apparently not confined to certain regions of Italy and is not dominated by mafia-type organizations. The findings indicate that individuals involved in illicit waste trafficking are typically white-collar criminals closely connected to the 'normal' business community who sell the ability to handle special waste at low prices to legal businesses. Since the 1990s, the issue of waste management has played an increasing role in the development of societies like those of Eastern European

which were facing unprecedented exponential growth in waste production. Consequently, efforts were made to adopt and reinforce ever stricter regulations, which substantially increase the costs of treating waste and give rise to a new form of crime.

‘Although difficult to measure, this emerging threat, which has serious consequences for society, will continue to develop given that waste output increases every year and treatment costs are proportional to the dangerous nature of the products. Estimates put waste output at over 1.5 billion tons. 20% of this waste requires special treatment for recycling or elimination’⁹⁸. These recycling procedures are particularly expensive. It has been estimated that the reprocessing cost can reach €1,500 per ton, while shipping and burying the waste in the beaches of Somalia cost \$30 per ton. Some manufacturers, waste collectors or processors can be tempted to significantly boost their profits by moving waste out of the legal processing circuit. This will start the chain reaction of illegal actions that can include: unauthorized dumping of waste; exporting waste to Third World or emerging countries in exchange for hard currency and other valuable commodities; illegal recycling by mixing dangerous products with authorized materials; corruption of functionaries, bribery, sinking ships on the high seas, extortion and even killing of witnesses. These operations provide rich earnings estimated at several billion euros worldwide. The situation is made worse because it is difficult to implement repressive measures, and the criminal sanctions are weak compared to the profits made. For these reasons, this form of trafficking is particularly attractive to the ‘ecomafia’. It can also attract the attention of established criminal organizations searching for new activities. These groups know how to take advantage of the opportunities offered by the opening up of European borders and by globalization, hiding their activities behind complex financial schemes. In addition to these environmental and health hazards, other consequences are financial, via the underground economy and money laundering, and social, with jobs put at risk in Europe (unfair competition) and also in the countries to which the illegal waste is shipped.

3. A New Concept for Security

During the last ten years all nations concentrated on one single form of terrorism, and we were convinced that this form was the major threat to our stability. Some nations thought they could fight in isolation, and in the meantime other challenges emerged from our own reactions and vulnerabilities.

⁹⁸ *European seminar on the fight against international trafficking in toxic waste 7.10.2008.*

From the output of military operations against terror and even from many peacekeeping operations, we should have learned a few important lessons: 1) nobody can fight alone against complex threats; 2) nobody can win fighting one single threat at a time; 3) a war without an end is a war without victory; 4) a crisis that cannot be solved after ten years of international administration is a failure; 5) a persistent crisis is not a crisis anymore but a failure; 6) a state that does not have a good perspective to overcome the crisis or to be recognised by the international community is a failed state; 7) coalitions must not kill alliances; 8) we should act in a multidimensional environment, integrating specialized assets, sharing data and developing new specializations.

Finally, we should have learned by now that real security is linked to and depends upon People Welfare.

A new definition of security is needed, and it must include reconciliation, freedom of movement, the return of refugees, war crime prosecution, law and order, a sound judicial system, good economy, higher employment rate, fair resource management, threat awareness, shared responsibility, transparent authority, nation building and regional environment. Security requires also bringing transitional systems to maturity through unified control of both military and civil powers, self-sustainability and political autonomy. Security is social development: nobody can be free and safe if they are hungry or humiliated. Security equals effective political guidance and legal control over the controllers. Safety goes hand in hand with this type of security.

4. Multiple Threats and Single Minded Approach

Unfortunately, for such a multiplicity of threats there are neither the kind of command nor the kind of control and efforts the situation would require. In the crisis areas, a multitude of national and international organizations and forces still operate, each of them loosely connected to one or more focal centres. In addition to that, each of these agencies has an individual view of the problems and a personal approach. Within NATO itself, which is responsible for the military part of the security in Kosovo and Afghanistan, there is not a common understanding on what the soldiers are allowed to do. Many nations, for example, question the legitimacy of the military conducting search and cordon operations, going after organized crime, detaining suspects or even using force when necessary. There is still a tendency to couple the military with a pure military threat, the police with a criminal threat, civilian governmental agencies with corruption, and financial crime and political authorities with extremism. There is no doubt that each area of interest requires specialized personnel, but in the crisis areas it is also true that everything leads to the establishment and maintenance of security. In the crisis areas the risk of convergence of criminal activities with extremism and even

terrorism is very high. Furthermore, the risk that those activities pollute politics, economy and reconstruction and that they fuel disturbances, ethnic rivalry, turmoil and rebellion is even greater. Therefore the classic partition between military and police competences and jurisdiction in these cases is a mistake. However, it would be no less a mistake to ask for the militarization of security. The military forces have the duty to deal with those threats because they interfere with the general security, slow down the process of nation building and hamper the capability of the government, but they cannot be left alone and given responsibilities that would interfere with democracy. What we need is a better use of the available resources asking for the best they can provide in mutual cooperation and integration of efforts. The military forces do not possess the training and the expertise to deal with crime or extremism in the investigative sense, but they do have a special equipment and knowledge in gathering and assessing intelligence, controlling territory and monitoring any kind of threats. It would be nonsense to think of preventing and combating modern threats in the crisis and destabilized areas without recourse to these military capabilities.

5. The Operational Networking

During the last 20 years the European armed forces have cooperated in many fields of security and they have become aware that the control of territory is not what it used to be. From the operational point of view, the control of territory is not a matter of surveillance, patrols, border control and physical security. Nowadays physical control has shifted from 'framework' activities like patrolling, searching and 'carpet' check points to 'intelligence led' operations. Random search and cordon operations, loose territory denial, or simple presence do not represent the best choices for security operations. Intelligence must not only provide the targets, but has to lead the operations both in planning and execution. If the intelligence is active, it has to go hand in hand with the operations. Unfortunately this concept is still underdeveloped, and in fact each organisation keeps its own intelligence and its own database, not sharing it with anybody and often denying good information and providing the wrong information. Access to the intelligence database is one of the most serious challenges to the effectiveness of security. A related problem is the update of databases and their reliability. It is useless to start an operation in search of stolen cars if the Europol database is updated every six months. In the Balkans, stolen cars stay in a particular area from three to six hours. Then they are either shipped elsewhere or dismantled and transformed into spare parts. Another source of frustration for the security forces is having to check every single car at the state border while more and more free ports are created where container ships can load thousands of tons of waste and sail away freely. The fact is that during the last twenty years the quality and the

organization of the threat have drastically changed along with the change in business. The threat to safety and security is a composite one and is network-based: the criminal and extremist networks have always a connection to politics, administration and economy, whether directly or indirectly, tight or loose.

The focal elements of this model are of course ‘not the nets, but the knots’, and the links between ‘compatible elements’. These ‘compatibles’ are selected knots that instead of performing a function inside the basic net of cells, ensure the connectivity with other networks. They are often individuals not necessarily engaged in the practice of crime/terror/extremism and often are so powerful, prominent and disguised as to become ‘untouchables’. More often than not they are not chiefs, but the major enablers of the cell life. The linkage, the other focal element of this model, is still the traditional family relation or the personal acquaintance. However, this tradition is fading away as well. The major link is now the interest in a particular project. Often the ‘compatibles’ do not even know each other and they can prove to the police that they have no connection to any individual engaged in crime. When they are political figures or administrators they can endorse laws and regulations that indirectly favour their own network, but more often somebody else’s network.

It is obvious that fighting against this threat model requires a mental approach, a type of knowledge and tools that traditional military and police do not always have and master, especially if they act antagonistically.

6. Territory and Environment

If the traditional perimeter of the state territory does not limit the responsibility of the government in safety and security anymore, the territory of organized crime has expanded in an even greater sense. The mafia territory was once defined as ‘the space between boundaries’, where the boundaries did not match the legitimate state or administrative borders, but related to clan affiliation and territorial control. Today some threats to security still have these kinds of boundaries, but they are relics of the past. The rural and city gangs have this type of territorial organization. Smuggling is bound to routes and means of transportation. Families and clans still have their home territory where they exercise power without any need to perform criminal activities inside it. However, territory has recently acquired the additional meaning of functional domain and specialization. The Colombian drug dealers do not only perform power control inside their own boundaries, but they control the entire coca market around the world through the ‘cartel’, which is an economic tool and not a geographical area. Moreover, today the definition of territory has acquired another powerful and scary meaning – environment; but, again, not only the physical environment, which is put in danger by human activities; rather, the complex sphere of situations, events, natural and social conditions that can

influence the ordinary and orderly life. Control of territory has therefore to become more virtual than physical and more related to behaviour than to geography. Restricting the security forces inside a fixed area of responsibility is a legacy of the past and a serious mistake.

The fight against crime, extremism and terrorism must rely on a concerted control of the environment well in advance of the fight against individuals and beyond the traditional areas of responsibility. We need a transnational control system that really can integrate and coordinate the different forms of prevention and contrast. We cannot be really successful in establishing security if the banking system allows the profitable transfer of money and money laundering. And this control over money does not have its centre of gravity inside areas of crisis like Kosovo, the Balkans, Iraq and Afghanistan. As a matter of fact, the control must reach the well established, calm, safe and sunny places where money is kept and handled. We cannot go after corruption if public and international functionaries are protected by privilege, immunity and impunity. We cannot claim victory over crime in one place and then ignore the fact that the major 'knots' of international crime have freedom of movement and enjoy high respect around the world. By the same token, we cannot claim victory in one place and declare defeat in another. Our defeat is global if crime, terror and extremism even temporarily move out of a certain area and establish elsewhere. Therefore it is evident that the fight against current threats to safety and security must adopt the same global approach and the same networking organization as do the threats. Of course, we cannot dispatch military forces all over the world to fight crime and instability. However, even when engaged in a fixed Area of Responsibility (AOR) with strict limits and rules of engagement, the security forces deployed in crisis areas can monitor the events happening inside their AOR and warn of their possible consequences abroad. We have to concentrate on these effects and indicators and start looking at the threat networking and at the means to disrupt it. We need to get rid of the old mindset and make some reasonable assumptions. For instance, we can assume that the local population know much more than what they are willing to say. In particular the local chiefs, administrators, politicians, religious and ethnic leaders know exactly what is happening, how and why. Often they know also who and when, even if for their own protection in many instances they would rather not know. In the case of political extremism, we can also assume that each political entity has its own intelligence and fighters. The international forces can easily become targets of espionage, sabotage and direct attacks. In other cases they are subject to political and psychological pressure and intimidation, the threat of losing credibility and authority.

We can also assume that the 'locals' are not necessarily those living inside the AOR. Immigration into some areas is emigration from others. The Diaspora is always linked with the homeland, and what happens in the host nations immediately affects the life and the behaviour of the homeland, and vice versa.

Therefore the penetration and knowledge of the 'local' entities must expand to the communities abroad.

Many activities affecting local dynamics have long-distance connections. The origin of the threat is far away and the end users of the criminal acts are in most cases remote and not even connected with the AOR. The period of criminal transit is often so short that bureaucratic structures and unaware forces do not even perceive the threat. That is why the territorial and environmental control must expand into a global network able to reach and identify, through key indicators, the terminals of the threat, the organization and the victims themselves.

7. 'Krisis' as Opportunity

Intelligence is the key factor to the mission. It must be actionable, operationally exploitable, timely, reliable and coordinated. There is no security operation without intelligence, and nowadays only intelligence-led operations are possible and necessary. Information and influence operations are also essential to the mission, provided they are managed very carefully. The fight against extremism and terrorism and the preservation of a safe and secure environment require the fight against organized crime. In addition to the criteria of conducting intelligence-led and cross-boundary operations, the security forces should learn how to be more effective and less visible; how to cooperate with other assets, enhance their technological capability, cooperate with the judiciary and integrate their strength into a system that allows the 'environmental' control. This kind of control should focus on trends, unexpected patterns and behaviour that could produce illegal profit, unfair political advantage, obscure economic development and acts of violence and even terrorism. This type of 'environmental' control must rely upon key indicators that only apparently do not have a close connection with military and security responsibility. This control, much more than physical territorial control, requires a deep penetration into the society and a full understanding of crime, terror and extremism in addition to mastering the dynamics of economy, society and finance. It is not a task that can be performed in isolation from the regional environment or by a single force. It needs a unified vision and an integrated strategy. The key indicators must be available to the whole network and treated according to a 'network' (and not 'concentric ring') concept of priority. The growth of financial crime in Europe is more visible in Cyprus and the Cayman Islands than in Brussels. That is why the 'concentric rings' approach is tailored to an old and merely geographical approach. The composite nature of the threat, its chaotic and complex behaviour, its adaptability to the multiple changes of the environment, its flexibility, require more than ever a concerted and integrated approach. If this is necessary in 'normal countries' that are civilised, stable, democratic and even rich, where crime, extremism and terror do not

threaten the stability of the foundations of the institutions, we can imagine how badly the 'environmental control' is needed in the post-conflict and emerging regions where institutions are in transition and therefore in 'Krisis'. In those areas the risk of failure is great, and failure means the formation of geopolitical 'black holes', areas of permanent instability, delay in human and economic improvement and the birth of rogue states, non-states, quasi-states, failed states and mafia states. Our great opportunity is to take advantage of the global 'Krisis' to change our approach to safety and security, to understand the new dynamics of a global threat and to test our assets in order to deal with the vulnerabilities. No other places than this part of the world today offer better chances of success. If we stay together.

PART II

RISK: PREVENTION, MANAGEMENT AND MODELS

DECISION SUPPORT SYSTEM FOR CRISIS MANAGEMENT

PLANNING

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Abstract Governance of the transport of hazardous materials requires complex decision making regarding regulation, routing, land-use, and resources for emergency response. Decision-makers need to balance the needs of various actors, such as industry and the public; they must take a multi-hazard approach, they must take into account the spatial dimension of the problem, and they must know the vulnerability of their territory. Therefore, they must have appropriate decision support tools that facilitate the required integration of information.

During the last few years the European Commission DG Joint Research Centre developed a number of such tools. Following the general phases of a typical risk management cycle, the presentation will illustrate their main characteristics and analyze their application in the safety and security domain.

This paper presents the main results gained during the definition and the implementation of such systems. It also comments on the main limits and gaps imposed by data unavailability or interoperability constraints.

1. Introduction

Industrial risks in the EU are largely related to chemical hazards. The complexity of issues concerning rational decision-making has become complex, and consequently, such decisions are becoming more and more difficult to make. Overlaps between environmental, industrial, social and political issues and the rapid speed

of change contribute even further to the complexity. Environmental industrial policies aim to reduce human health impacts and ecological risks, but at present they are not effective in fully accomplishing the programmed goals because they are not consistent with the economic and social needs (Di Mauro, 2001).

For the chemical industry, main guidelines for risk management are given in EU Directives such as SEVESO II. But the implementation into national legislation varies a lot within EU. Thus, no unified presentations of industrial risks exist in the EU. On the other hand, not all activities using hazardous materials are covered by existing directives and legislation. This means that not all hazardous installations and activities are automatically covered in territorial risk assessment. When there are no rules to follow, information transfer to other stakeholders like civil services does not exist. This creates huge demands for territorial risk and vulnerability management and especially for emergency preparedness planning.

Decision-making around preventative actions to reduce the risks and vulnerabilities is based on the social and economic risk evaluation and understanding of the general risk perception. Planning for preparedness is based on the analysis of systemic and industrial risks and their risk and vulnerability zones in a territory. Measures for preparedness contain emergency planning; training of civil services, volunteers and relevant stakeholders; risk communication planning; and interactive communication with the general public of systemic and industrial risks present in a territory. Preparedness stage of risk management is the basis for successful response to and efficient recovery from an emergency situation caused by systemic or industrial hazards.

Efficient and transparent cooperation needs supportive tools and networks that enable interactive, online communication between all relevant stakeholders both for risk and emergency management purposes.

This paper illustrates the role of a Decision Support Tool in the domain of management of dangerous goods. The first part describes the different management phases and the structure of decision support systems. The second one describes the experience gained in the field of safety and security.

2. Management of Risk Related to Dangerous Goods

The risk management cycle is typically described according to the following phases (Atkinsons, 2003):

- **Prevention and Mitigation:** Different organizations will follow different methodologies to analyse and produce results on different scales for hazards, vulnerabilities and risks. The resulting maps can be used in turn, for example, to build scenarios and aid planning. In the preparation phase emergency plans will be produced. In the following phase (Reconstruction) results will be used for land use planning.

- **Preparation:** From analysis in the previous phase, emergency plans will be validated. When an alarm is activated, emergency scenarios can be run to determine how best to organize the territory in order to minimize the impact of the event; this could include the need to use sophisticated forecasting models. Additionally, pre-emergency plans might be used to communicate to the affected stakeholders, and alert the appropriate decision-makers.
- **Response:** Geospatial information accessible through information services allows more timely interventions of teams and more efficient management of the operation on site. Additionally, non-spatial information like procedures, emergency plans and authorization modules can be quickly accessed and communicated. Further, information on critical infrastructures and services damaged by the event will be needed in order to prioritise actions needed to protect the affected society. Finally, efficient and reliable communication channels will be necessary to assure the transportation of this information between the appropriate decision-makers and other emergency management actors.
- **Recovery:** Primarily, information on damaged infrastructures and services will be needed as well as possible population location, in order to prioritise actions to restore them. Further on, in order to start rebuilding both analysis of the impact event and the results of previous risk analysis (from the Prevention and Mitigation phase) will be needed in order for decision-makers and stakeholders to agree on the best actions to take.

Each of these phases is characterized by a specific decision-making process and source of information. It is clear that access to valid knowledge from different information sources is necessary in order to accomplish the activities in a timely fashion with high quality results. One most important complication correlated to the efficient development and implementation of each phase is related to the interaction between different stakeholders and decision-makers on different administrative levels and territorial boundaries.

In addition, the inappropriateness of the data for decision support activities, the lack of integration between systems, and poor coverage of data make the task of creating a truly useful Decision Support System almost impossible. Since data related to the impact of industrial activities (e.g. environmental, economical, social), present a very high level of heterogeneity, and are stored in a multitude of repositories, it is straightforward to deduce that the information required by an efficient decision-making process needs to be based on a distributed architecture. Moreover, the information required by the decision-making process could change according to the requirements of involved stakeholders. Thus, the decision-making process typically characterized by multiple and conflicting objectives needs to be supplied with up-to-date information and managed by a flexible system able to satisfy the requirements of stakeholders.

3. Decision Support Systems

In general terms Decision Support Systems are a specific class of computerized information system that assist people in making decisions based on data that are gathered from a wide range of sources. Decision Support System applications are not single information resources, such as a database, a model or a programme that graphically represents results and figures, but the combination of integrated resources working together. The structure and the design of a Decision Support System can vary according to the skill and aptitude of the decision-maker and the needs of the decision-making process.

At present it is common practice to collect and store the required information in static databases and perform risk analysis by stand-alone models. Because of the high heterogeneity and multitude of distributed repositories of information required by such a complex decision-making process, a risk management system should be based on a distributed structure whose information can be assessed dynamically according to requirements of the decision-making problem. The definition of such a complex approach for the definition of policies for sustainable development of industry derives from the fact that decision-making is an iterative cognitive process that cannot be rigorously described. Therefore, decision support applications must be built in a manner that permits changes to occur easily and quickly. Decision-makers and stakeholders need to collaborate using an iterative process that involves continuous changes.

For such reasons we propose to improve the definition of Decision Support Systems, designing a system based on a data warehouse. A data warehouse is made up of integrated software tools on a hardware platform, which forms an architectural proposal. Such a proposal is directly related to the environment of the source data. The structure of the system and the data warehouse may be considered as a six-layer architecture (Kelly, 1996), namely:

1. **Operational Data** is the operational computing environment, which provides the source data for the corporate data warehouse. The online transaction systems of sources such as environmental quality network or models generate most of this data. The objective of the data warehouse is to minimize the disruption in the operation of the operational systems. As such the only software introduced will be the extraction and/or propagation software required to capture the data needed for the data warehouse.
2. **Data Migration** is the system consisting of devices and functionalities for the retrieval, conversion and migration of data from the source to the target computing environments. Data needs to be transformed in such a way that it ensures that the target database contains only timely, integrated, valid and credible data.

3. **Data Warehouse** is the system where the information is stored. Two characteristics of this system are important (Fig. 1):
- Metadata** – that summarizes the characteristics of the data stored on the data warehouse. Metadata supports the user in understanding the data, i.e. it illustrates how the data is organized, how old the data is, what the data source is, etc.
 - Data Granularity** – The amount of detail that is incorporated into a data warehouse is referred to as data granularity. The different users of the system will require different types of detail of information.

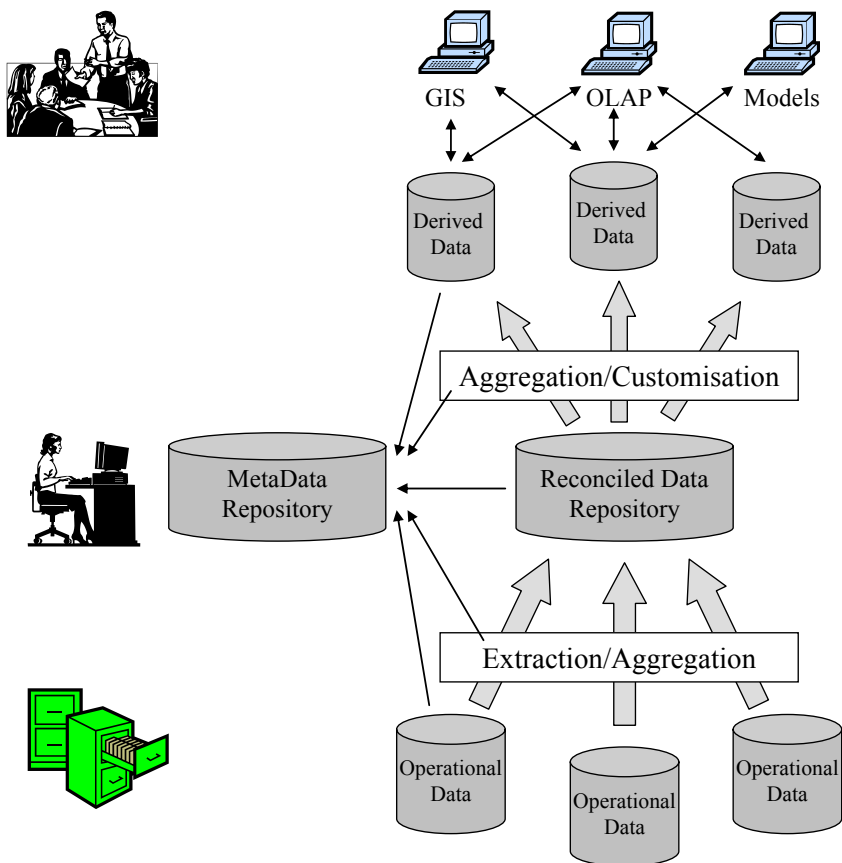


Figure 1. Scheme of the distributed information and role of a Data warehouse.

4. **Middleware** refers to the systems required in order to provide access to the data warehouse. Depending on the size and type of target audience, this may be as easy as setting up a few access terminals or as complex as having to set up a LAN or WAN. The Middleware software is in effect responsible for allowing the application that is resident on a client to execute a request for data, which is located on a database server (the data warehouse).
5. **Decision Support Applications** refers to the software that is used to access and analyze the data resident in the data warehouse. Since the data warehouse is built to support decisions, the applications are fundamentally different from the process automation applications commonly used in operational systems.
6. **Presentation Interface** refers to the means by which the decision support application is presented to the user.

3.1. DECISION SUPPORT SYSTEMS IN THE FIELD OF SAFETY

This chapter summarizes the experience gained by JRC during the development of long-standing, reliable and cost-effective infrastructure distributed over a large territory amongst numerous public bodies (Atkinsons, 2005; Atkinsons, 2006).

According to our experience, the system architecture of a decision support system for the management of dangerous goods (Fig. 2) can be decomposed into a number of fundamental blocks or subsystems, each subsystem responding to a particular set of needs or services that starts with fundamental data acquisition, its monitoring for exceeding predefined threshold values, its validation and its archiving.

Data is collected from a number of sources including existing air quality monitoring networks and meteorological forecast services. A number of advanced air dispersion models automatically provide regular forecasts of dispersion over the territory on provincial and regional bases. A system supporting the planning for emergencies and their management in case of industrial incidents is also included. Finally a data warehouse integrates all generated data together and elaborates it using dedicated OLAP tools.

The main subsystems can be outlined as follows:

- The **Monitoring Management Centre** collects and validates data from monitoring networks. This centre is also responsible for sending alarms.
- The **Analytical Instruments Laboratory**, a state of the art analytical instruments laboratory (for campaigns in the field) including a mobile emissions station. Validated data from this subsystem is sent to the Environmental Data Elaboration Centre.

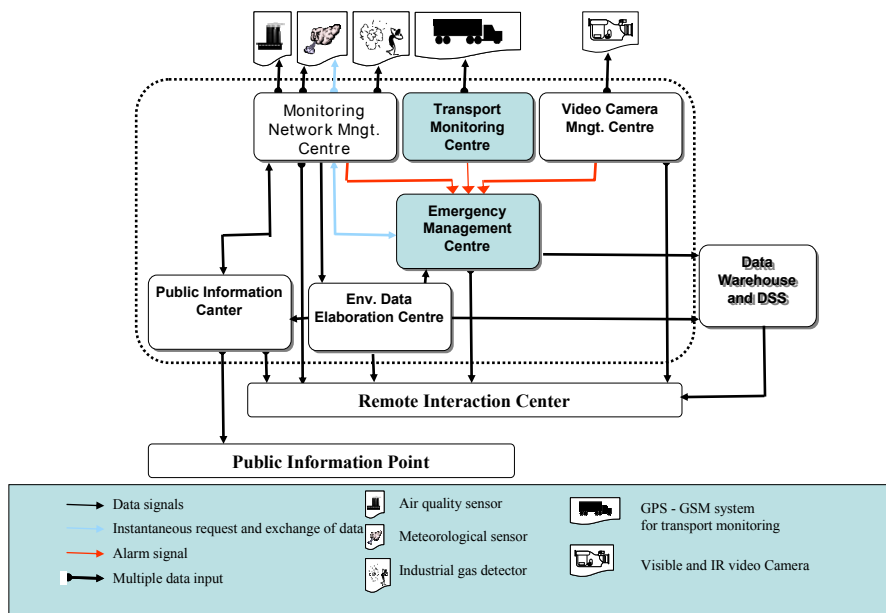


Figure 2. Architecture of a Decision Support tool related to the management of the transportation of dangerous goods.

- An **Image Management Centre** surveys industrial installations with infra red and visible spectrum cameras, able to detect hot spots (explosions and fires) and cold spots (leaks of high pressure gas). In addition to periodically capturing images, this telematic system sends alarms to Environmental Data Elaboration Centre and Data Diffusion Centre when hot spots or cold spots are detected.
- The **Environmental Data Elaboration Centre** consists of two main modules: a Cadastres module and a modelling module. The modelling module contains a number of advanced codes that automatically exploit downloaded meteorological data for modelling the dispersion of pollutants over the territory. Some of the model's processing chains are automatically activated when alarm signals on pollutant thresholds are received from the Monitoring Management Centre.
- A **Data Diffusion Centre** integrates relevant data from the other subsystems into a single web portal for dispersion to a wider audience, including the general public. Part of the portal has private access for official entities. Additionally, the portal provides the possibility for requests to use the on-line data warehouse reporting and analysis modules.

- The **Emergency Planning and Management Centre**; the focus of this centre is more oriented towards industrial and technological risk management and the support for civil protection entities in the case of an incident. The information contained in the database covers: industries at risk and the substances that they contain; other technological risks in the territory; the scenarios of possible incidents; resources available to civil protection bodies; procedures and documents issued in the case of an incident; the main entities who have responsibility for the territory and logs of intervention in the event of an emergency. Again a GIS module is included for both the emergency planning and emergency management modules.
- **Data Warehouse**; the data warehouse integrates all data from the other peripheral data centres. It processes the data using a number of dedicated OLAP (Online Analysis and Processing) modules which provide automated reports on environmental pressure indicators. Having both a dedicated client server application and a web access application, reports on the data can be defined, run and investigated with classic OLAP techniques such as Slice, Dice and Drill.

An important characteristic of this system is that it is distributed over a territory; a number of techniques are used for data communication. A high speed dedicated telematic network between the main data centres to the headquarters where the data warehouse is located is required.

3.1.1. *Role of the DSS during the Prevention Phase*

The main functionality of a DSS during the monitoring phase can be summarized as follows:

- Monitoring the position of vehicles over the territory
- Showing maps including vehicle current and past trajectories
- Statistical analysis of vehicles' journeys
- Telemetry
- Reception and management of alarm signals
- Identification of vehicles in risk area
- Communication with vehicles
- Interface and support to emergency management centres
- Traffic management

3.1.2. *Role of the DSS during the Emergency Phase*

During the emergency phases the DSS can play a relevant role because much of the relevant information can be provided automatically to the decision-makers and

performs a number of predefined actions. The most relevant aspects related to this phase can be summarized as follows:

- Automatic alarm recognition
- Identification of the place and type of emergency
- Inform all relevant entities
- Consequence assessment and definition of impact zones
- Identification of most vulnerable areas
- Coordination of available resources
- Visualize quantity and type of substance
- Visualize road name and location (motorways direction., etc)
- Identification and tracking of procedures
- Communication, coordination and reporting
- Automatic road block identification

Moreover, alarms and the relevant information can be broadcast to vehicles transporting dangerous materials, or more generally to mobile phones present within a certain radius from the accident spot.

3.2. DECISION SUPPORT SYSTEMS IN THE FIELD OF SECURITY

There is no record of any significant terrorist attempts made against the transportation of dangerous goods or to the freight transport network, especially when compared to those suffered by the public transport sector in the recent past. Nevertheless, the freight system might be attractive to terrorism for a number of reasons, the first being targeting the supply chain itself, with the scope of affecting the economic and social system (Counteract, 2007).

Urban areas contain a high concentration of civilian targets, resulting from a combination of high population density, and a large number of high value assets in general. Introducing a security zone that protects a whole urban area or large parts thereof, instead of hardening all individual targets, may in some cases be preferable. However, such a zone may introduce economic disadvantages to businesses operating in the area, cause annoyances to the general public, or be disadvantageous in other ways.

Alternatively, terrorists could smuggle weapons through the supply chain to facilitate attacks not directly involving the supply chain. Moreover, the freight network could prove attractive due to the nature of some of the goods it carries, that is, particular types of hazardous cargo, 'weaponized' and immediately or ultimately exploited by terrorists, either as a form of blackmail over the threat to use it or through its actual use against specific civilian targets.

Recognition of the above threat has motivated an array of security reforms. Complete protection is, however, unrealistic and economically unfeasible. Therefore, in order to allocate limited resources, there is a need for a systematic approach to the identification of significant risks from terrorism and the development of effective measures to manage them.

A decision support system can help decision-makers during the planning activities in order to identify the most vulnerable areas or the areas of concern that can require the definition of a protection strategy. The following pictures (Fig. 3, 4, 5) show the hypothetical map of the explosion effects on urban sensitive targets. The DSS can assess the efficiency of a protection strategy related to restricted area.

During the monitoring phase the DSS can collect and elaborate the information provided by the sensors which control the access of vehicles to the sensitive zone. The system can check the clearance of each truck, and it can elaborate the statistic about the number of the transit, the time permanence in the restricted area and the way out. In case of violation of any rule associated with truck permit, the system is able to generate pre-alarm and alarm signals. During the emergency phase the system can support the closure of all the gates and their control.

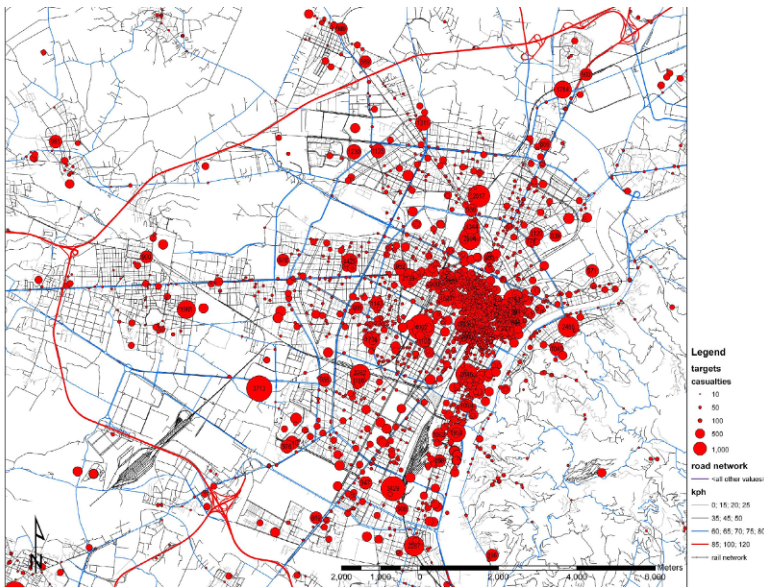


Figure 3. Example of sensitive targets distribution in a town and representation of population potentially impacted by an explosion (Counteract, 2007).

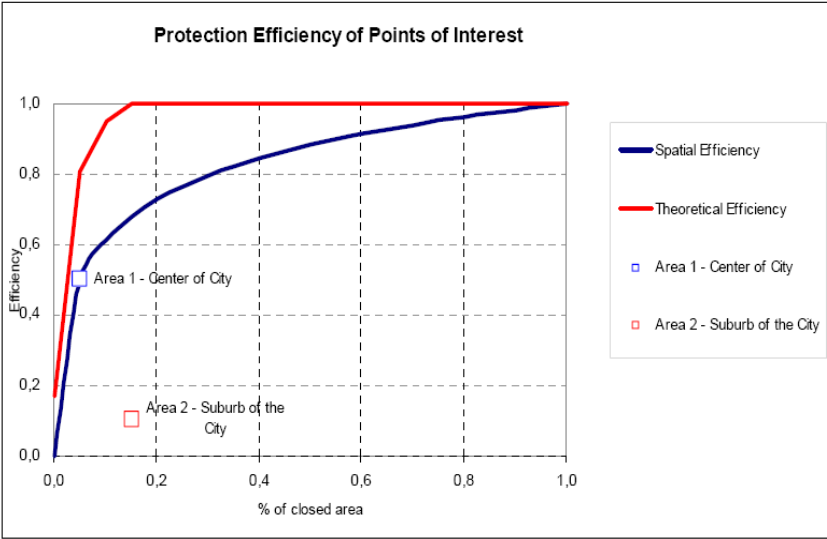


Figure 4. Example of a comparison of the protection efficiency of two different urban areas and considering only sensitive targets. Area 1 is rather efficient because it is close to the efficiency curve calculated for the town. In contrast, Area 2 is inefficient (Counteract, 2007).

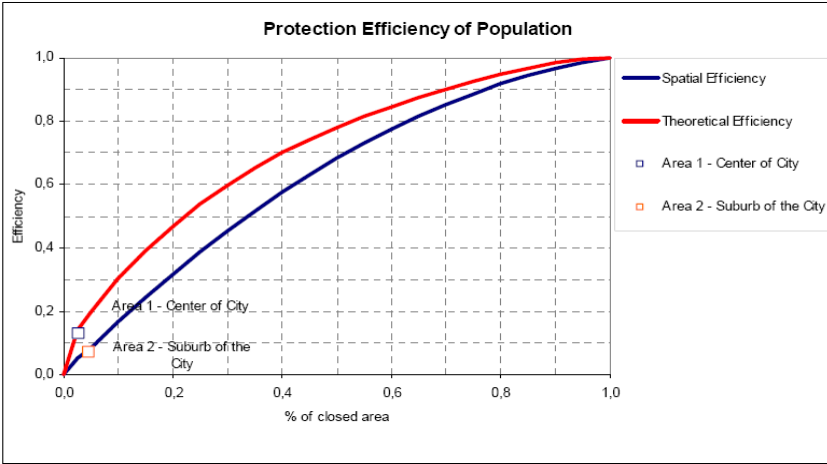


Figure 5. Example of a comparison of the protection efficiency of two different urban areas and considering the urban population distribution (Counteract, 2007).

4. Conclusions

Addressing systemic risks and vulnerabilities in Europe requires a cross-sectorial approach for identification, prevention and mitigation of systemic risks. This can be achieved by building multidisciplinary partnerships amongst authorities, experts and institutes on systemic risks to coordinate the cooperation between different sectors at the appropriate level (local, regional, national and international). This also helps to overcome possible conflicts of interest between different stakeholders and service providers. Efficient cooperation requires advanced tools that support interactive communication at all levels throughout the risk and vulnerability management lifecycle.

Decision-support systems have been demonstrated as being valuable tools in the field of management of dangerous goods and prevention of crisis. They rely more and more on complex information technology architectures and powerful communication technologies. Such technologies are mature, but there is operational constraint related to the cost of communication. Therefore, the challenge for the coming years is not related to improvement of the available technology but more on the definition of a feasible and sustainable business model able to reduce the operative costs of public controllers and decision-makers and to stimulate competitiveness among the private operators. Private sectors have already put in a lot of effort in order to improve the safety and security of the transportation of dangerous goods, but improvements are still required. In addition, public authorities need to improve the control and monitoring activities, which requires a large investment of public money.

Therefore, the following questions remain open and need to be systematically addressed in the coming years:

- How much safety/security is still required?
- How much does it cost to implement more efficient monitoring and management systems? Who is going to pay?
- What are the benefits? Who can benefit from it?
- How can administrative and technical procedures be harmonized?
- What kind of adoption? (on voluntary basis; compulsory; governmental subsidies)
- Who will manage the collected information?

Considering the nature of such questions, it should be argued that the answers need to be researched more on the political agenda. Decision-makers need to balance the needs of various actors, such as industry and the public; they must take a multi-hazard approach; they must take into account the spatial dimension of the problem; and they must know the vulnerability of their territory. The available technology is mature for supporting them.

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THE PRIM (INTEGRATED REGIONAL PROGRAMME FOR RISK ASSESSMENT AND MANAGEMENT) BY LOMBARDY REGION

ANDREA ZACCONE AND CARMELA MELZI
Lombardy Region

The PRIM, Integrated Regional Programme for Risk Assessment and Management, has followed a path of modernization and renewal, going beyond all expectations. It has been created as a result of the regulatory requirement which calls for a review and update of the Regional Forecast and Prevention Program (Lr 16/04).

The inspirational motive was to create, thanks to an easily modifiable and flexible instrument, an authentic **Integrated Security System**, to engage the new security and prevention policies in an open manner, without claiming to be holistic in any way, but on the other hand to engage and involve an array of sectors.

The **validity** of this instrument, as it develops during the legislature and the coming years, shall be in its becoming the coordination centre of regional risk prevention policies in the Lombardy region, setting the guidelines for the regulatory norms at a provincial and municipal level regarding security and prevention.

Risk integration – Mitigation – Transfer of residual risk-monitoring and Surveillance – Information and communication – Assessment of policy impact.

But what are the bold choices made by the PRIM?

The first is that of **contextualizing** security, prevention and the policies that are active in the Lombardy region. Hence, certain risks were chosen, those more important than others, and a choice of analysis and integration of these was carried out based on morphological, social and economic characteristics of the region.

The chosen risks:

- Hydro-geological, distinction made between flooding and landslides;
- The risk of earthquake that lies in the south eastern part of the region;
- The industrial risk, which globally speaking, firms in the Lombardy region count for 20% of all the national industries at risk;
- The increasing meteorological risk, which lately has been devastating;
- The risk of forest fires, for which the Lombardy Region has the latest fire-fighting capacity.

Other social and human risks were included as risks derived from:

- Road accidents;
- Accidents at work;
- Urban insecurity.

These risks were studied and researched by university experts in Lombardy to provide an exhaustive vision of the problem areas and give importance to the need for new **knowledge** which these risks require, given that no in-depth study had been carried out since 1998, the year in which the earlier Prediction and Prevention Programme had been approved.

The second important choice of the PRIM, which intentionally emphasizes the conditions for a real 'security partnership', is **involvement**.

At least two levels are touched upon by this important choice:

- The research collegiality in the regional Government, seeking to share knowledge with those who deal with prevention tasks in different areas;
- That of involvement towards the outside.

The first point was executed by carrying out a thorough census of those who, by norm or practice, deal with risk assessment in the Lombardy region. Once the identification phase was concluded all the subjects were asked to participate in the creation of the PRIM.

The second point was executed thanks to two strategic and interesting involvement strategies: the collection and assessment of all activities performed by the institutional actors dedicated to prevention and security (including a cost assessment of the prevention activities on a regional basis) and the creation of the most acceptable and objective action appraisal instrument.

Let us now address the third choice, a direct consequence of the second, which helped to create the PRIM: **sharing**.

Obviously, the involvement of internal and external security actors has inevitably led to a joint understanding of the choices made, and hence created a useful instrument that can be used by all.

Another two aspects were considered during the creation of the PRIM:

- The opportunity of it being a **training device**;
- The likelihood of creating an **instrument to communicate the policies executed by the local institutions for the security of the citizen**.

Above all, because of this latter aspect, during the drafting of the PRIM a parallel task of creating a brand/trademark to identify all the activities and tasks in this area was undertaken.

The brand, '**Prevenzione Lombardia: la sicurezza come sistema**' ('**Prevention in Lombardy: security as a system**'), is meant to be a sign of quality which the security actors will use to communicate the steps they are taking.

As far as **training** is concerned, the PRIM will provide training courses at three levels: the political level, technical and institutional level and information to the population, above all the youth.

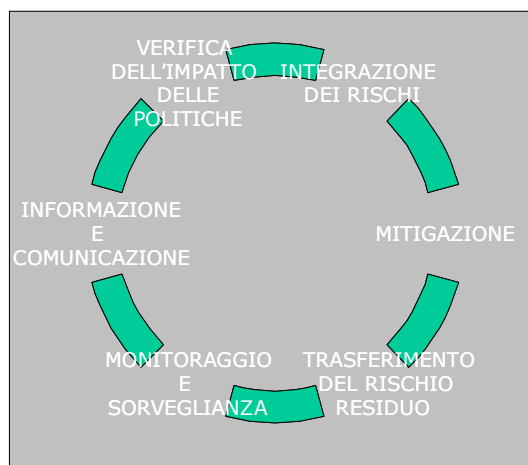
Among the major results of the PRIM, besides the update of the state of risk, the inclusion of new and emerging risks, there is the **integration** of these elements in order to obtain the integrated risk report.

The final product of this integration process is the **multi-hazard map** and a **regional map of integrated risks**.

The difficult road to this result began with the creation of an adequate level of regional knowledge about risks which was mapped on 1 km by 1 km square cells. The integrated risk was calculated using indicators rather than using a probabilistic approach that did not allow the aggregation of such diverse risks.

The total risk is thus defined as $TR = PR * (1+F)$ where PR is the direct physical risk and F is an indirect impact factor that explains the potential level of indirect damage as a consequence of the capability and potential of society to react and face the direct damage (function of the *coping capacity* and *social fragility*).

The integrated risk map has been achieved by integrating, adding the total risk maps for each of the eight detected risk areas thanks to an operational procedure known as AHP (*Analytic Hierarchy Process*) and providing the 1 km cell results and aggregates to the municipal level.



The choices and challenges of the PRIM

The analysis and data processing did not stop here, but with the data in our possession, and based on the integrated risk maps, the most critical risk areas were detected. And so a map was obtained that marks the areas which show the presence of simultaneous, overlapping risks (at least two) that are three times

higher than the regional risk standards, making it possible to highlight those areas with particularly significant security problems. That is why these areas, a total of six, are considered as worthy of further study regarding integration, ‘domino effect’ of different dangerous events and their consequences.

This will allow us to carry out more in-depth analysis of the areas in the future, and with a greater degree of detail, through what have been defined as ‘Plans for Integrated risk of the area’.

Such an in-depth study is already in progress regarding the first priority area which includes a large part of Milan’s metropolitan area.

The latest on risk assessment is the modified approach devised at the National University of Colombia by Professor O.D. Cardona, who with the *Risk Management Index* (RMI) and by grouping a series of indicators that represent the performance of a country, region or area in its risk management, can classify the same areas.

With the current data at hand it has been possible to modify and adapt the index for Lombardy, which in reality was devised for other areas and lands different from ours.

The results obtained will be the subject of further study by the province and the individual municipalities in the coming years. The results have helped to obtain a clear general picture of what has been done and what can still be done to study risk **assessment** and **mitigation** policies regarding the citizen’s overall insecurity. A multi-temporal analysis of the RMI has shown how in some of the risk categories a lot has been done in the last few years, and that a lot can still be done, above all regarding optimization and updating of databases, for emergency planning and coordination between local players, institutions.

A very comforting piece of data is the feedback showing greater knowledge of the phenomena both on a technical-scientific level (greater knowledge) as well as from the population (communication and training).

The work done has been worthy and extremely stimulating but the challenges that need attention are many. We have tried to summarize them into the actions described below:

1. Creating an Integrated Security System Future Tasks

Knowledge

- Develop an indexing system of risk via the RMI at a province and municipality level.
- Develop knowledge about the risk in ‘uncovered/exposed’ sectors.
- Increase collaboration and relations between academic world and local institutions for focused investment policies.

Education

- Diminish the existing gap between citizens' scientific knowledge and perception of risk.
- Diminish the existing gap between decision makers' scientific knowledge and risk-related knowledge.
- Increase individual and collective responsibility on risk assumption and preventive actions for the personal security of citizens.
- Increase a resilience culture.

Administrative/institutional activities

- Solicit and call for the insertion of an integrated risk vision and indexing via RMI in the planning stages within the province (PTCP) and municipality (PGT).
- Develop a culture of financial transfer of residual risk.
- Develop effectiveness indicators for risk reduction activities and actions.
- Provide incentives and coordinate the creation of an integrated system on prevention policies at an institutional level.

2. Viewing the Integrated Area Risk Plans: Three Levels of Planning



2.1. PRIM

This first level of integrated risk planning is at a regional level. The term 'integrated risk' is meant for 'level or grade of criticality' or in other words 'insecurity' caused by a variety of risks. Hence, the areas at 'risk' are those with concurrent presence of sources of danger and elements exposed and vulnerable to such sources, the area's resiliencies considered. The accuracy of the total risk figure on the map representing the entire territory of Lombardy has a degree of precision set by the degree of knowledge of an individual phenomenon in a given area. The total risk is codified with the use of a grid map with 1 km by 1 km

squares, calculating for each cell an average spread index throughout the whole area, including the area of the cell. The PRIM refers to greater detailed information required to devise and analyze Plans for the integrated risk of the area.

2.2. AREA PLAN

The second level of planning is aimed at detecting the area's integrated risk, or in other words the risk a limited area is subject to in the short, medium and long term, given the presence of multiple risk factors that might react independently (composition of risk problem⁹⁹) or together (domino effect problem¹⁰⁰), paying close attention to risks that have low chance of occurrence and a high magnitude of damage and using, among these, technology as a risk guide factor.

The integration must consider objectively and with a view to the context the risks present across the area, giving priority to the more serious issues that emerge. This refers above all to the sources of risk, and represents the need to consider all risks present in a given area as under one of the following categories of potential events:

- Coexistence of more events at the same time;
- Linking together of certain sequential accidents (technological effects with domino effect, TEC-TEC);
- Linking together of different types of accidents that can increase the criticality of the natural risk, leading to its occurrence (domino effect TEC-NAT);
- Complex events due to sources of natural danger that set off other dangers like technology (domino effect NAT-TEC);
- Multiple natural events that feed each other (domino effect NAT-NAT).

Hence, this level of planning must set itself aims, even if ambitious, of studying major impact risks present in the given area and assessing the interaction between these. In particular, it aims to develop the degree of knowledge regarding phenomena that occur simultaneously, linked phenomena, as they have been described above. It must devise a systematic vision that in addition to the sources of risk will also consider the social and geographic (territorial) exposure and vulnerability more precisely than the last planning level of the PRIM. Even by not going into the specific details, the target of this level of planning must collect and process information at higher than municipal level, enough to allow a planning of municipal details, assess estimates of expected damage and detect, in terms of macro-categories, the actions that need to be taken in the medium and long term, in order

⁹⁹ The expression 'composition of risk' is meant as the act of putting together, re-uniting the individual risks to evaluate total criticality with which the territory is affected.

¹⁰⁰ The expression 'domino effect' is meant as in taking into consideration the effects that are generated with relation to the main event.

to achieve a significant reduction and/or mitigation of the risk, in other words increase the level of social resilience. Furthermore, it is the task of this second level to detect relevant critical scenarios of interest at a higher than municipal level and enter only into the details of the same, devising intervention plans of structural and non-structural actions. As far as the criticality of the municipality levels are concerned, this second level of the plan just has to identify the categories of intervention and define eventual priorities.

2.3. DETAILED PLAN

The third level of planning is carried out with a detailed scale that accurately defines the degree of differentiated and differentiable local risk (assessment of possible scenarios also based on what has been observed, as in ‘domino effect’ in the local area plan) also within the same administrative area. The plan delineates with the same detail and precision (in other words for each possible scenario) the risk mitigation and reduction activities, along with economic estimates, feasibility reports and a list of priorities. This is done thanks to a system of indicators for the assessment of the efficacy of actions, (to be defined for certain risks – road accidents, hydro-geological and forest fires) with a view to come up with a multi-year action plan.

This level of planning requires a thorough knowledge of the local historic series of each risk that has been studied and a careful revision, as well as an assessment of the possible domino effects among the same in relation to the social exposure and vulnerability. This is done by taking into account the socio-economic and urban transformations that are planned and expected in the municipal area’s development plan.

THE PRIM PROGRAMME: A REGIONAL PLAN FOR INTEGRATED RISK ASSESSMENT AND MANAGEMENT

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Abstract The Lombardy Region has recently launched a project (PRIM – Regional Plan for the Governance of Risk) aimed at an integrated risk assessment as a decision support for local policies of risk prevention and management. The project has been developed and coordinated by the Lombardy Foundation for the Environment in cooperation with universities and research institutions of the region.

Eight major risks have been considered: natural (floods–landslides, extreme meteorological events, forest fires, earthquakes), technological (relevant industrial accidents, transport of dangerous substances) and social risks (labour accidents, road accidents, urban security).

For each of them, hazard factors as well as vulnerability elements for selected targets have been calculated, weighted and combined with proper algorithms in order to obtain GIS-based risk maps with a fine space resolution (1 km² square cells).

The individual risk maps have been overlapped and integrated, achieving a final integrated risk map capable of selecting the most critical areas throughout the region, to which specific policies of prevention and/or mitigation of the major risks ought to be addressed.

1. Introduction

1.1. ORIGIN AND NATURE OF PRIM

PRIM is a regional programme launched in 2006 with the aim of building regional policies for the safety and security of citizens on a new basis.

The premises of this effort can be traced back to the UN Conference on Disaster Reduction held in Kobe in January 2005. In this meeting a set of recommendations

was laid down, aimed at preventing the major risks impending on human populations. These guidelines point at some key rules:

- risk prevention and mitigation policies should be a national and local priority based on a sound institutional basis;
- major risks should be correctly identified, assessed and monitored and proper surveillance and early warning systems implemented;
- scientific knowledge, technological innovation and training/education actions have to be provided in order to build a diffused culture on safety/security and resilience capability at any decision level;
- hidden risk factors should be identified and reduced;
- training in emergency management should be strengthened as an effective response at all levels.

2. Basic Assumptions

PRIM's most innovative feature is the transition from a 'Risk Management' to a 'Risk Governance' system, coupling an integrated risk assessment to an organic set of prevention and mitigation policies. This approach requires a proper concept of *multi-risk* able to recognize the qualitative differences among different kinds of risks, the choice of an operational framework and a territorial representation and mapping of the integrated risk [1].

In the present context, the *Risk Governance* could be defined as a complete set of specific actions managed by the local governments and able to allocate financial resources and coordinate activities in order to reduce potential damages to population and economy. Particular attention has to be paid to social actors and institutional-economic stakeholders and to the set of rules, processes and mechanisms concerning data collection and analysis, information-communication and decision-making procedures.

Another crucial point of this strategy is constituted by the role played both by social risk perception and by the capacity of the physical, economical and institutional systems to respond to a given damage. The *resilience* or *coping capacity* could therefore be defined as the capability of the territorial, anthropic and infrastructural system to tackle given perturbations produced by relevant accidents and to effectively buffer their effects.

3. Major Risks Considered

The risks have been taken into consideration according to the following four criteria:

- strong human, economic and environmental impact;
- high social perception;
- pre-existing regional policies;
- availability of suitable indicators.

Consequently, eight major risks have been selected, belonging to three main categories:

- Natural Risks: wildfires, hydro-geological, seismic and meteo-climatic;
- Technological Risks: industrial;
- Social Risks (linked to socially relevant events): road accidents, labour accidents and perceived social insecurity.

4. PRIM's Objectives

PRIM's general aim was to identify *highly critical areas*, where the integrated action of some major risks should be urgently contrasted. The development of a risk mitigation strategy for these areas was then considered a priority objective of regional public policies.

More specific aims were:

- Updated reports (2006) on the existing state of the risks;
- Inventory of the interventions planned and in action (2007–2010) for risk mitigation;
- Location of the most critical areas in Lombardy;
- Realization of mitigation plans for each area;
- Logistics analysis of the transport of harmful substances;
- Creation of a management information system based on a GIS platform.

5. Methodology

In its common meaning, *Risk* is a function of the *likelihood* of a specific event occurring within a given period of time or in specified circumstances, also taking into account the *magnitude* of the event and the *damages* caused by that event.

5.1. FROM RISK ASSESSMENT TO RISK GOVERNANCE

The selected procedure of PRIM starts from the recognition, for each kind of risk, of a set of hazard sources and a corresponding set of vulnerability elements, both of which, properly represented in a GIS-based mapping system, lead to an integrated *risk assessment*. In a second step, a number of critical geographic areas

in the regional territory are identified and for each of them a *risk management* protocol is defined, taking into account the specific risk assessment, emergency management plans, action of risk reduction or mitigation and the available financial coverage (risk adaptation policies) [2]. The previous risk management protocols, combined with the role of specific stakeholders and the local social perception, determine the global *risk governance* (Fig. 1).

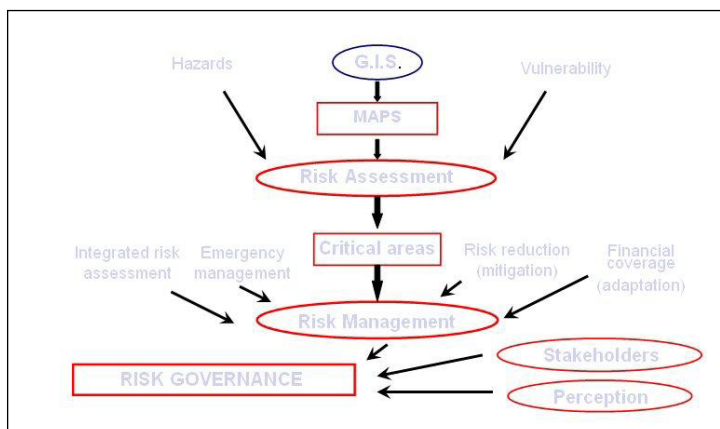


Figure 1. Scheme of risk governance.

5.2. LOCATION OF CRITICAL AREAS

In order to select first the most critical areas of the region and then to create their specific risk management plans, a sequential series of studies has been developed starting from a proper definition of integrated risk, a parallel definition of ‘integrated risk area’, the choice of methodologies for risk mitigation actions, the selection of efficiency indicators for the actions, the realization of ‘Multi-Risk Maps’ [3] and the generation of specific integrated action plans for each selected area.

5.3. CLASSICAL VERSUS SELECTED RISK ASSESSMENT PROCEDURE

In traditional risk assessment protocol, the risk is calculated as a probabilistic function of the likelihood of occurrence of a given event and of the likelihood of damage produced by the same event. Vulnerability and protection factors, as well as conditions capable of facilitating or counteracting the occurrence of the event, are taken into account.

Such a risk analysis is usually carried out by means of mathematical models. Starting from historical datasets and analytical information, the models estimate the probability associated with the occurrence of an event in a site during a specific period of time and with a certain magnitude level. A model of the target system (exposed and vulnerable) is subjected to some expected stresses. Possible scenarios are outlined and consequent damages estimated.

Different kinds of problems often make the pursuit of an Integrated Risk Assessment unfeasible according to the above-mentioned quantitative approach. Among these we mention the lack of homogeneity of risk components and their measurement parameters (recurrence, magnitude, damage typologies, etc.); the insufficiency of data and analytical information available at a regional scale; and the restricted time available to complete the task.

Given these difficulties, especially at a local level, we decided to shift from a quantitative analysis to a semi-quantitative (or quali-quantitative) approach based on the following criteria:

- choice of set of *risk indicators* defined as qualitative or quantitative measures defining, in numerical or descriptive terms, the critical state level of an area in regard to some events that may take place locally [4];
- selection of *risk indices* as aggregation of indicators summarizing the set of factors causing risk.

On these assumptions, a methodological approach was thus developed, based predominantly on spatial analysis techniques. This made it possible to produce maps defining the critical state level of the regional territory with respect to every risk category included in *PRIM*. Furthermore, it was possible to adopt an analytical approach, based on the numerical integration of the different Major Risk maps, aimed at identifying the *hot spots* (highly critical areas) to which the mitigation policies should be oriented.

The proposed approach considers at risk the areas with a concomitant presence of sources of hazards and elements exposed to those sources and vulnerable to their potential action, on the basis of the territorial resilience.

5.4. DEFINITION OF VARIABLES

According to our basic assumptions, an effective *risk indicator* can be derived from a geographic analysis pointing out the presence, in a specific area, of hazard, vulnerability and protection factors.

In this context we define *hazard* as the probability associated with the occurrence of an event in a site, during a specific period of time and with a certain magnitude level. It can be expressed as the presence of factors whose action can potentially produce damages.

The existence of the impact on a specific area is strictly correlated with the inherent predisposition of the territory to suffer damages in its natural or anthropic components and to their degree of resilience.

We define also *vulnerability* as the tendency of the physical, social and economic components of an area to suffer damages as a consequence of the taking place of some hazardous events. The degree of vulnerability is determined by the local presence of elements exposed and sensitive to the different sources of hazard. It can be more or less pronounced, as a consequence of the level of resilience of the study area.

Finally, we define the *coping capacity* as the level of organization of the territorial system and, hence, its capacity to face risks to which it is exposed.

Risk, vulnerability and protection factors and the territorial level of resilience are often characterized by specific spatial features, and they can be represented by means of geometric shapes and stored in digital geographic databases. The contextual presence of these elements in a specific area can thus be analyzed by means of Geographic Information Systems (GIS), a key instrument in risk assessment studies.

Traditional risk analysis studies single risk factors and relates them to the set of elements on which they could have an impact. Over a territory, however, a variety of elements is present, more or less vulnerable to a variety of sources of hazard. The whole set of these elements represents a model of the real world. When appropriately developed in a GIS platform, this allows the study of spatial relationships between sources of hazard and the elements they impact on, and finally leads to an integrated risk assessment.

Under these premises we can define *multi-hazard assessment* as the evaluation of the occurrence probability of dangerous events arising from a variety of sources/processes in the same site. In a similar way, we define *multi-risk assessment* as the evaluation of the occurrence probability of dangerous events arising from a variety of sources/processes in the same site taking into account the overall effects produced by different hazards with their domino effects and negative feed-back processes.

5.5. DATA AND SPATIAL STRUCTURES

In order to gain a spatial uniformity of the analysis, risk, vulnerability and protection factors have to be mapped by means of a univocal data structure. Our choice has been a data structure based on 1 km squared cells, particularly suitable for computing indicators and for integrated analysis [5, 6] (Fig. 2).

Each cell represents a portion of territory, a specific unit of analysis. Inside the cell, phenomena and processes occur. Risk indicators and indices, relative to every Major Risk defined by PRIM, have been computed for any single cell of the regional territory.

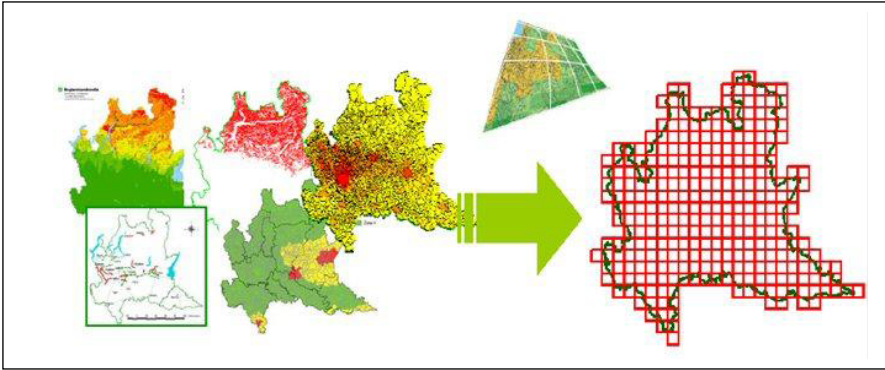


Figure 2. Data and spatial structure.

5.6. CALCULATION PROCEDURE FOR SINGLE AND INTEGRATED RISKS

The quantitative risk assessment procedure is based on three steps or phases and is conducted separately in each grid cell and for each category of risks. In the first step hazard and vulnerability indicators are defined, selected and combined with a linear algorithm of weighted sum where the weights for each element are assigned by a panel of experts. This first step produces the Physical Risk Map. The second step calculates the resilience indicators through their weighted sum, with the weight again established by a team of experts, allowing the creation of a map of the indirect impact factors. In the third step the two previous maps are linearly combined to produce the final total risk map.

For every cell of the regional domain the Total Risk values for each major risk have been integrated to calculate the final value of the Integrated Risk. This operation consists in a linear combination (weighted sum) of the single total risks. The weights have been assessed with the *AHP* methodology (*Analytic Hierarchy Process*) [7, 8].

6. Results

6.1. THE CASE OF INDUSTRIAL RISK

In order to illustrate the main results of the PRIM risk analysis, the procedure relative to the Industrial risk will be schematically presented. In this case, two categories of hazard sources have been considered: industrial plants ‘at risk of relevant accident’ (EU directive 82/501/CE) and factories contributing to a ‘diffuse risk’ on the base of a specific database (AIAP – risk score 6-7) created by the Regional Environmental Agency of Lombardy (ARPA Lombardia).

Phase 1

For each industrial plant subjected to the Seveso Directive a ‘buffer area’ has been drawn, extending 1000 m beyond the plant’s strict perimeter (Fig. 3) which represents the *potential area of impact*, in the case of a relevant industrial accident. This is of course a precautionary approach, since the exact location of the sources of hazard inside the firm’s perimeters is, for the purposes of the present study, generally unknown.

At the same time the vulnerability elements present on the same territory (potential impact targets of an industrial accident) have been selected (Table 1) and represented on the map (Fig. 3).

TABLE 3. Vulnerability elements.

Vulnerability elements	
Schools	Hospitals
Camping and tourist facilities	Railways
Railway stations	Electrical equipments
Urban areas	Industrial areas
Sport facilities	RIR firms perimeters
Road network	Airports
Watercourses	Resident population
Parks	Employees

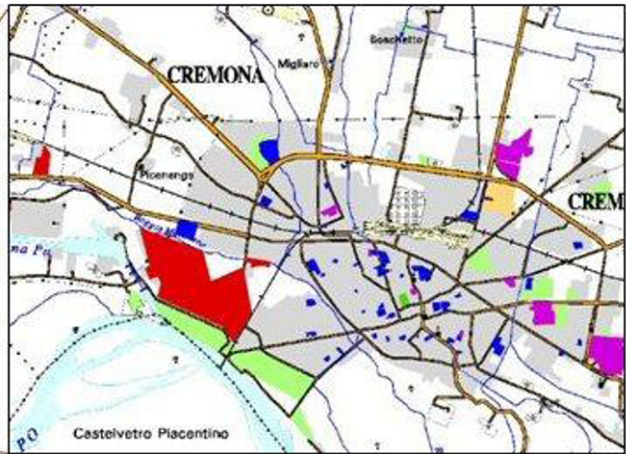


Figure 3. Map of vulnerability elements present on the same territory.

The two sets of elements (hazard sources and vulnerabilities) have been inserted into the grid cells (Fig. 4).



Figure 4. Grid cells with hazard sources and vulnerabilities.

Every territorial category vulnerable to industrial risk has been evaluated by a panel of experts who have assigned a given normalized weight to each of them. The weight represents the criticality of the potential involvement of each category in an industrial accident. For each cell of the grid domain all the categories of vulnerable elements have been assembled through a weighted sum, using the weight factors previously assigned by the expert group.

Combining the two sets of information concerning the hazard sources and the vulnerabilities the *Physical Risk Map* has been obtained (Fig. 5).

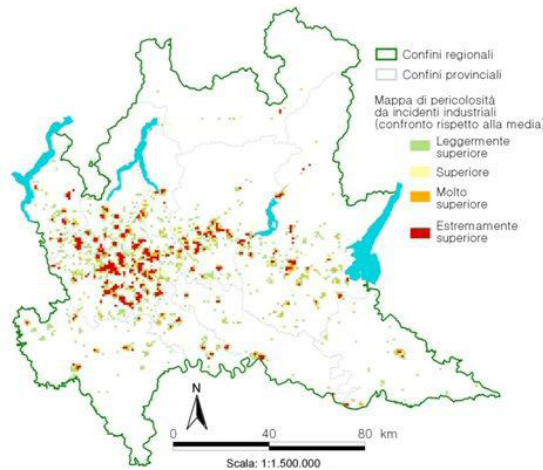


Figure 5. Physical Risk Map.

Phase 2

In order to evaluate the coping capacity (degree of resilience) of a given territorial area with regard to the industrial risk, the so-called Indirect Impact Factors have to be recognized (Table 7).

TABLE 2. Indirect Impact Factors.

Vulnerability elements	
Schools	Hospitals
Camping and tourist facilities	Railways
Railway stations	Electrical equipments
Urban areas	Industrial areas
Sport facilities	RIR firms perimeters
Road network	Airports
Watercourses	Resident population
Parks	Employees

For each element which contributes to determine the resilience of the territory a weight has been assigned by a panel of experts. The weighted values have been summed up to produce the Map of the Indirect Impact Factor concerning industrial accidents (Fig. 6).

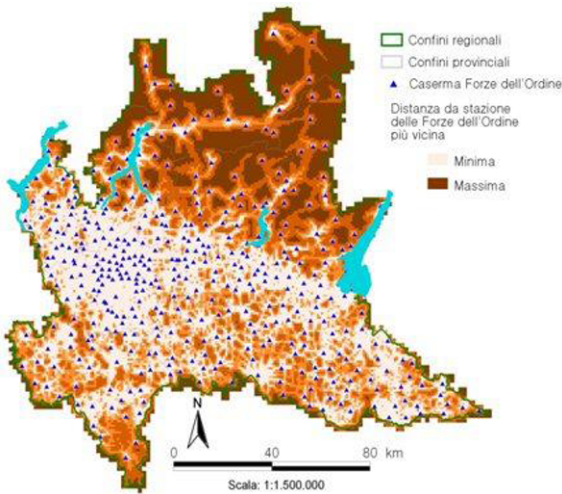


Figure 6. Indirect Impact Factor concerning industrial accidents.

Finally, the Physical Risk Map and the Indirect Impact Factor Map are combined with a proper algorithm to give the Total Risk Map (Fig. 7).

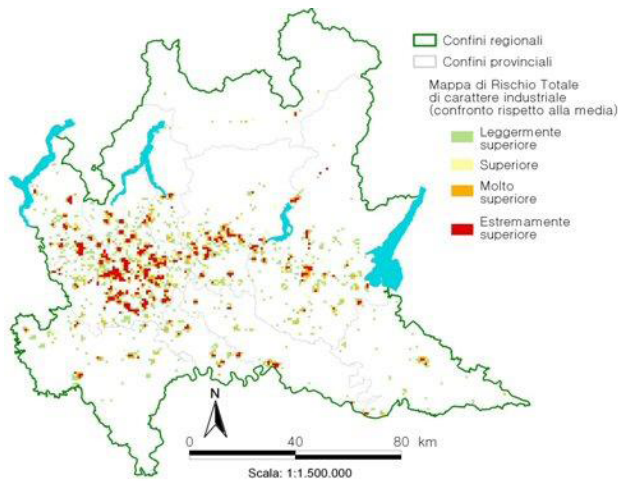


Figure 7. Total Risk Map.

6.2. ASSESSING AND MAPPING THE INTEGRATED RISK: THE CRITICAL AREAS

For every cell of the grid, the Total Risk values for each major risk have been integrated to calculate the final value of the Integrated Risk. This operation consists in a linear combination (weighted sum) of the single total risks. The weights have been assessed with the *AHP methodology (Analytic Hierarchy Process)* (Fig. 8).

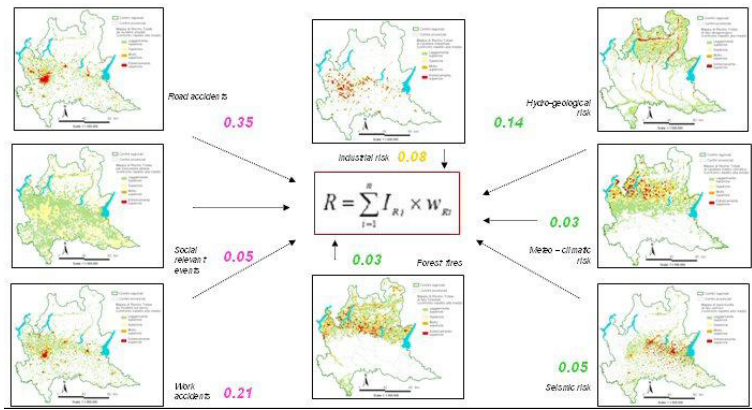


Figure 8. AHP methodology (Analytic Hierarchy Process).

The data concerning the single risks allow two kinds of representations. If just reported separately into a map they produce the Dominant Risk Map (Fig. 9) which gives an immediate idea of the weight and territorial distribution of the single risk categories.

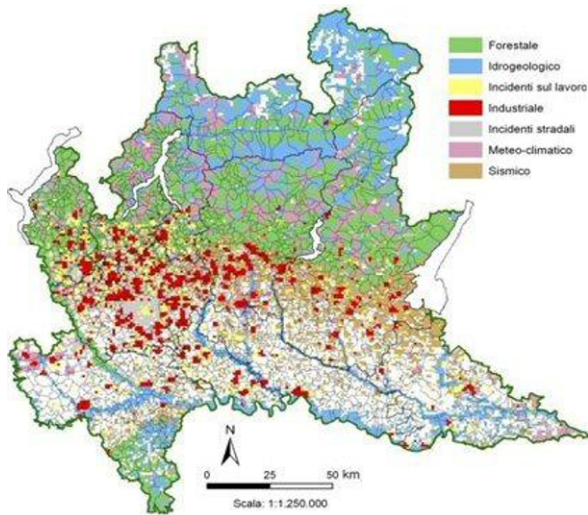


Figure 9. Dominant Risk Map.

Alternatively, if the values of each grid cell are summed up according the AHP procedure, an integrated risk territorial distribution can be obtained, and represented by a scale of risk levels (Fig. 10).

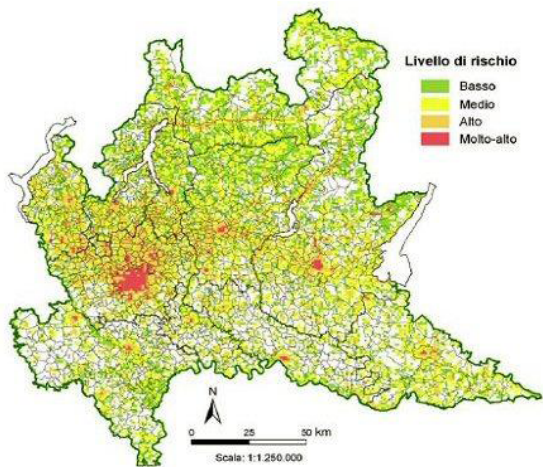


Figure 10. Integrated Risk Map.

The single grid cells can be grouped together according to the geographical borders of the municipalities present over the regional territory. In Fig. 11 the separated area of municipalities can be seen. This kind of representation makes it easier to assemble groups of municipalities in areas of significant extensions characterized by a high level of integrated risk. Taking only clusters of contiguous cells of area larger than 25 km² a map of the critical areas of the region is finally obtained. (Fig. 11).

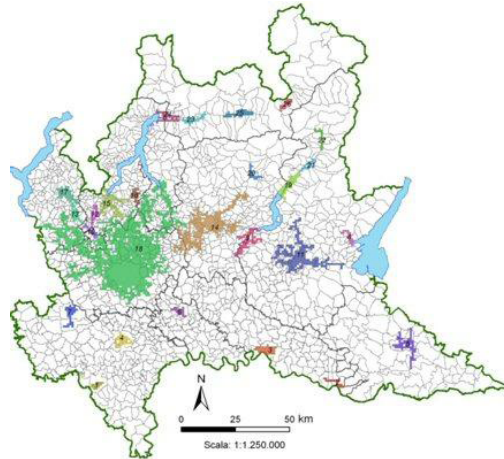


Figure 11. Map of the critical areas.

7. Conclusive Remarks

The PRIM project of the Lombardy Region aimed at an integrated risk assessment to support decisions in local policies of risk prevention and management. Eight majors risks – natural, technological, social – have been included in the risk assessment process.

For each of them, hazard factors and vulnerabilities related to potential impact targets have been selected, weighted and combined with proper algorithms in order to obtain GIS-based risk maps of integrated risk over the whole regional territory with high spatial resolution. Thanks to the integrated risk maps, a number of hot spots (critical areas) have been located, where specific policies of prevention and mitigation of the major risks might be successfully addressed.

The methodology adopted differs from the traditional quantitative risk analysis based on probabilistic functions, since it is based on single or complex risk indicators which are not able *per se* to give a precise numerical estimate of the occurrence or the damage produced by a given dangerous event. Nevertheless, the

project has been successful in giving a reliable evaluation of the cumulative risks impending over a given territory, offering also a tool to gather more specific information about the single risks. On the other hand, the adopted approach, al-though less precise, allows the definition of proper mitigation and adaptation policies in a framework of risk governance shared by local government institutions, social actors and economic stakeholders.

Another advantage of PRIM's 'risk philosophy' is that it can be applied to any kind of potential risks, including those dependent on environmental pressures like the emission of polluting substances into the air, in ground or surface waters and in the soil, so offering a powerful instrument to counteract potential impacts on human health, ecosystems and the cultural heritage.

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HOW CAN RISKS BE MANAGED IN LOGISTICS NETWORKS

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Abstract Risk Management is a subject of growing interest both in academic research and in business communities. Nowadays the industrial environment is highly dynamic and sometimes unstable. Because of the structural complexity and volatility in logistics networks, there is an increasing need for a decision support system that is integrated with risk assessment and management procedures. In this study, we aim to investigate the fundamental steps of risk analysis and management, then present a conceptual framework of a design methodology for a well-suited control mechanism and systematic decision-making process of logistics networks under the influence of disruptive factors.

1. Introduction

In today's global marketplace, logistics networks have become more complex with the functional interactions among industries, infrastructures, logistical hubs, urban areas, altered transportation modes, legal procedures, and societal aspects (Pezzullo and Filippo, 2009). The literature on logistics and supply chain management is plentiful; however, the proposed methods have some limitations in handling the degree of complexity inherent in production–distribution networks in practice. In particular, most of the existing models can only describe a restricted class of the real-world systems with simplifications, and they often fail to consider disruption factors or unexpected situations. Although some recent literature deals with risk management from the logistics point of view (Jüttner, 2005), these studies generally look at the vulnerabilities of single organizations, and often focus on a single point of view such as supply, demand, product or information management (Tang, 2006). Besides, risk assessment and management in the global environment capable of handling interactions and cause-and-effect analysis of different risk factors has not been well addressed in an integrated framework. A logistics network is subject to the risk of failures, which is mainly due to the uncertainties in the system. It is highly important to respond to disruptions due to uncertainty in a real-time manner. Logistics management without considering risk issues in a systemic

perspective and their impact on the performance measures eventually leads to suboptimal results and inconsistent processes. Thus, the primary question is how logistics operations should be managed to capture unexpected events while both maximizing the customer satisfaction and minimizing the total cost. To deal with the real-time decision-making problem of logistics networks is the driving force behind this study.

2. Risk Management Process

According to the Association of Project Managers, risk is defined as an uncertain event or set of circumstances which, should it occur, will have an effect on the achievement of one or more objectives (APM PRAM Guide, 2004). A typical process of risk management contains four basic steps (Hallikas *et al.*, 2004; Mussigmann, 2006; Tuncel and Alpan, 2007). This procedure seems to receive consensus in the literature and is applicable to risk management in logistics processes as well.

- The first step is risk identification, which helps to develop a common understanding of the future uncertainties surrounding the network system, thus recognizing the potential risks in managing these scenarios effectively. Some of the examples for transportation failures include damages or loss of a shipment due to accidents, or delayed arrival of a vehicle because of heavy traffic, natural hazards or terrorist attacks, and so on.
- The second step is the risk assessment, which refers to the assignment of probabilities to risk-bearing events in the system and identifying the consequences of those risk events defined in the first step. Associating probabilities with risks is not an easy task and requires tedious work. Statistical analysis of appropriate sets of historical data derived from the company's own experiences, other companies' performance results or forecasting analysis, can be utilized to this end.
- After the identification and assessment of potential risks in a network environment, and understanding where to focus attention, risk management decisions and actions are to be applied as a third step. These actions include, in general, risk taking, risk mitigation, risk avoidance and risk transfer. The back-up scenarios should a pre-identified risk actually take place (i.e. reactive actions) or the risk mitigation actions to act directly on the pre-identified risks in order to reduce either the occurrence probability or the degree of severity of its consequences (i.e. proactive actions). The risk mitigation scenarios have the purpose of improving the reliability of the processes. For instance, they may represent crew training for reduced human error probabilities, shorter maintenance intervals or new equipment for transportation systems for a higher technical reliability, selection of the best route for transport or a higher

level of safety stock (Nedeß *et al.*, 2006). A mitigation action reduces the risk of failure, and a certain cost is incurred to put it in place. In order to make a comparison among different possible mitigation actions (e.g. shall we put in place preventive maintenance or renew the vehicle pool?) one should study the cost profile of each action separately. The possible control and detection process is assessed to determine how well it is expected to detect or control failure modes or the probability that the proposed process controls will detect a potential cause of failure or a process weakness.

- And finally, the fourth step is risk monitoring, where the system is supervised to detect the risks when they occur. Since the SC environment is dynamic, the risk status also changes in time. Therefore, risk factors and changes in the network must be monitored to identify the potential increasing trends in their probabilities and consequences, and new possible risk factors.

Even though there is a consensus on the above procedure, there exist a wide range of risk analysis methodologies for the realization of the above steps in an industrial environment (Tixier *et al.*, 2002). A widely used method for risk analysis is the Failure Mode, Effects and Criticality Analysis (FMECA). FMECA is a well documented method used to quantify and analyze safety concerns for a product or a process (MIL-STD-1629A). As an input, it takes plans and diagrams, probabilities and frequencies based on historical knowledge. As an output, FMECA provides a list of the most critical risks as well as some target mitigation actions (Tixier *et al.*, 2002). Other methodologies for risk analysis include; What-If methodology, Checklist analysis, Hazard and Operability (HAZOP) analysis, Fault Tree Analysis (FTA), and Event Tree Analysis (ETA). These methods will basically result in an initial listing of the hazard and associated consequences to help the decision-maker to further discriminate the importance of hazards, initiating events, and subsequent controls (Laul *et al.*, 2006).

3. A Framework of a Decision Support System for Risk Management in Logistics Networks

Because of the aimed cost reductions, the transfer of concepts such as lean management, focus on efficiency rather than effectiveness, trends to outsourcing and offshore manufacturing, centralized distribution, reduction of inventory holding/adopting just-in-time practices, and so on, the modern logistics networks have become more vulnerable, and hence the risk portfolio of each entity within that network has increased (Christopher, 2005; Kersten *et al.*, 2006). Thus, the direct and indirect consequences of poor decision-making will become more critical. To handle these negative implications, the logistics management concept has to be extended by complexity and risk management methods.

Generally speaking, risk analysis in logistics is still in a primary stage, as there are only a few models in the literature, and they are mostly too simple to represent real-life problems. Due to the complexity of decision making in logistics processes, and the uncertainties inherent in real-life business environments, an interactive computer-based system, which can be defined as a set of procedures in a model format, is indispensable to process data and judgements in assisting managers in their decisions. Thus, the decision can be considered as a consequence of dynamic interaction between three overlapping circles of information, preferences, and alternative solutions (Boose *et al.*, 1993). An integrated flow control framework that is capable of handling the dynamic and stochastic nature of logistics networks helps to identify innovating strategies for designing high system performance.

To this end, the general framework for developing a decision support system (DSS) which helps managers to make control decisions effectively and efficiently by considering the current status of the logistics network is identified. A specific DSS provides support on the strategic level, on the operational level, and problem-solving processes. At the strategic level, it supports the selection process of the most efficient design alternative that meets the user requirements. On the operational level, it assists the business managers in analyzing the performance of their existing system and in determining possible ways for modifying the system to improve the overall network performance. A DSS with its ability of helping decision-makers utilize data and models in a semi-structured or unstructured environment is an ideal candidate that can be easily implemented to solve such a risk management problem. In this manner, risk sources inherent to logistics operations should be investigated to establish a typology of the explored risks, and finally to integrate the risk management issues in modeling, planning, and real-time control of logistics networks.

The main requirements and characteristics of a DSS for logistics management can be stated as follows:

1. Be capable of handling the complexity of the real-world logistics design and management problem;
2. Adopt a heterarchical structure and decentralized control architecture focusing on distributed information and distributed decision-making paradigm;
3. Support all decisions phases;
4. Flexibility, adaptability, and robustness;
5. Modularity, maintainability;
6. Deadlock prevention;
7. Improve effectiveness of decisions;
8. Dealing with resource contention, conflict resolution;
9. Effective risk management in an integrated form of safety reporting, evaluation and inspection to meet the crisis within an urgent time frame.

The proposed DSS consists of main components given in Turban and Aronson, 2001. The intended system exploits a set of technologies and theories, such as Failure Mode, Effects and Criticality Analysis (FMECA), Probability of risks occurrences, preliminary risks analysis, graphical interface, fuzzy logic, object-oriented modeling, and client/server paradigm. The fundamental components of the DSS are as follows: a database system, knowledge system, model-base system, and a user interface system.

1. *Database system*: the database system includes information and data obtained internally or externally. It stores order processing data, process plans, which contains the set of operations to be performed, the order constraints among operations, the nature and extent of the material, resource requirements, local variables, geographic information, object parameters, and collects system performance measures;
2. *Quantitative model or system*: a model (e.g., simulation model, object modeling technique diagram) that processes the data and performs certain functions combined with stochastic modeling and fuzzy logic to represent the behavioural uncertainties in the system;
3. *Knowledge-base system*: provides intelligence; it contains safety concerns, risk sources, policy knowledge, state descriptions, route-dependent factors, heuristic rule base and emergency plans for decision making, and evaluation of the system performance;
4. *User interface system*: a control and dialogue subsystem through which the user can communicate with the system. It includes a graphical interface, a natural language interface, and an interactive dialogue interface.

The system described here employs an object-oriented modeling of the environment and adopts distributed decision-making paradigm. In this framework, a logistics network operates through the cooperative behaviour of many interacting subsystems which may have their own independent data/attributes, interests, values, and manners of operations/methods (Rumbaugh *et al.*, 1991). Thus, control can be distributed throughout the system by flexible and efficient interactions among all entities of the system, and conflicts can be solved by defining some well-formed models and simple rules. As Lin (1993) explains, object-based architecture is used to keep the modeling framework separate from system details so that any change can be made without affecting the functionality of other components and the analysis can be performed quickly at a moderate cost. In this framework, to reduce the uncertainty for planning, the risk management will be integrated in the decision-making process and will interact with the knowledge management. The decision alternatives at any point depend upon the current system state. An integrated control paradigm which keeps track of the system status and resolves the conflicts is developed by providing a powerful communication and efficient interactions among the system entities. The uncertainties related to demand,

production and distribution are taken into account by decision-makers through simulation experiments, and risk factors are represented by stochastic modeling. Thus, the proposed modeling methodology will help the user to define and focus on key attributes in a comprehensive framework. Virtual logistics comprising integrated models of logistics operations and associated business processes will allow the study of a logistics system as a whole and exploit the integration of the sub-systems for better design and operation (Jain *et al.*, 2002). The general structure of the DSS is depicted in Figure 1.

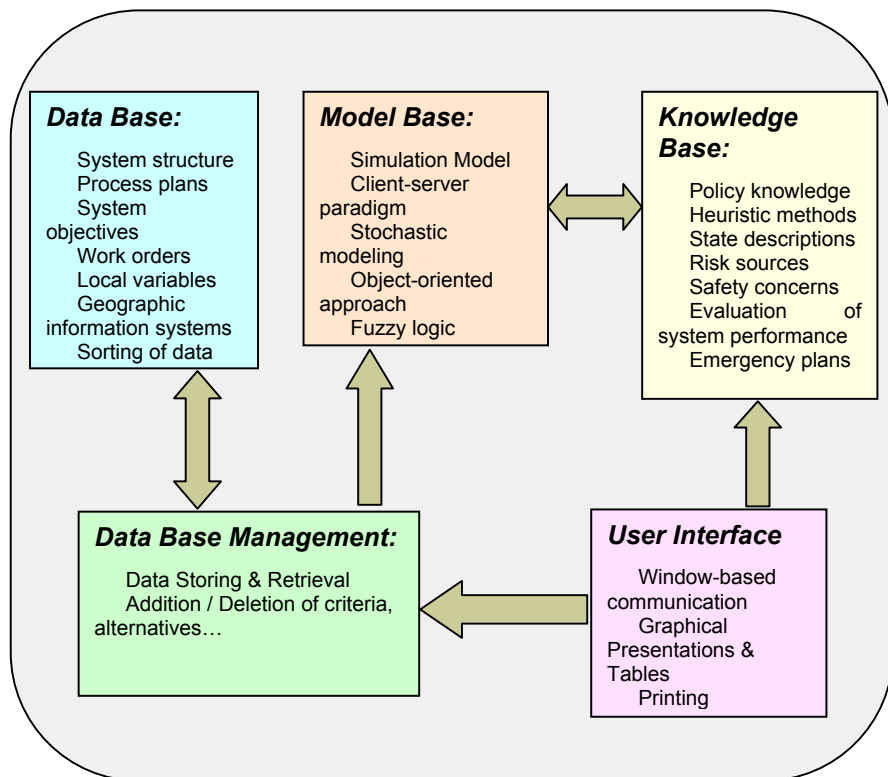


Figure 1. The general structure of the decision support system.

4. Conclusions

Economic, political and social developments over the past decade appear to stimulate the risk of disruptions in logistics networks that involve more partners for the requirements of global sourcing. In order to cope with the failure/error modes effectively, it is worthwhile to develop a decision support system which

provides a computerized support for decision making through tracking of material and information flow in the distribution network. Hence, it can be used in the decision-making process of the logistics under the influence of disruptive factors by maintaining current status information of the entire system, and properly generating the required data. In real industrial environments, the sources of uncertainties are numerous, and in order to get reliable results we need to have a reliable estimation of these uncertainties. Besides, the risks and their impact vary a lot according to the branch and company size (Hallikas *et al.*, 2002). Therefore, instead of finding the optimal levels of system factors, which cover the ever-changing operation conditions, it is much more fruitful to develop such a methodology that it provides the system designers with the procedures and helps them to carry out the evaluation by themselves under their own operational conditions. The flexible and modular design structures can help the rapid implementation of new operational conditions (Tuncel and Alpan, 2007). A new perspective could be to develop a backup system that can gather and adapt automatically to the new operating conditions. Such a backup system will thus help reduce failures and prevent propagation of the problems to the rest of the system. As the size of the distribution networks increases, the dependency between the entities increases as well. Thus, the concept of risk sharing becomes an issue of risk management and can be considered as a future research perspective.

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LOGISTIC PLAN FOR TRANSPORTATION OF DANGEROUS MATERIAL IN LOMBARDY REGION

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Abstract The transportation of hazardous materials is a growing problem world-wide due to the increasing volumes being transported. In fact, as a consequence of industrial development, huge quantities of hazardous materials are yearly produced, and obviously the production of them goes together with their transportation. Historical evidence has shown that accidents due to hazardous releases during transportation can lead to consequences as serious as those created by fixed plants, and therefore quantified risk analysis also has to be carried out for transportation networks. In this paper a flexible decision support system is proposed to quantify risk due to different transportation of dangerous substances – by road, rail, pipeline and inland waterways. First, a brief discussion is given on methodology adopted for evaluating risk. Then, the steps of the algorithm that has been implemented are sketched out in some detail.

Finally a description of the software is provided. Supported by a GIS-data bank, where parameters of the different transport networks are geo-referenced (i.e. incident rate, number of vehicles per year), the software provides a method of quantifying Individual and Population Risk. Some applications in relation to possible risk mitigation are discussed, such as the influence of a new road or reduction of quantity transported, thus confirming a possible use of this instrument by the decision maker in territorial planning and emergency management.

1. Introduction

As a consequence of industrial development, large quantities of hazardous substances, such as raw materials, intermediate or final product and waste, are moved through the transportation network by different means – such as road, rail, pipeline and inland waterways. In the last 15 years the scientific community has focused attention on the quantified risk analysis of hazardous material transportation.

Analysts have extended the techniques developed for fixed plants to these particular risk sources, and the tendency in recent years has been to create

territorial planning instruments, thus combining risk analysis know-how with Geographical Information System potentiality.

The scope of the paper is to present a methodology that has already been tried experimentally in Italy, in Lombardy, where the Public Authority has decided to create a decisional support system to quantify risks due to the transportation of dangerous substances.

The approach could be applied at regional scale in other contexts, and Lombardy represents a pilot study for planning risks about transportation. The study has been geared in relation to some critical indicators regarding Lombardy:

- around average concentration of company/activities (30 activities per km², the highest in Italy);
- around industrial activities classified by Seveso laws: 25% of the country;
- around transportation of dangerous substances. In Italy, 70,000,000 tons are transported by road and 5,000,000 by rail. Lombardy represents 25% of the former and 50% of the latter.

2. Risk Management System Adopted for Evaluating Risks Due to Transportation of Dangerous Substances on a Regional Scale

A risk assessment analysis for a specific transportation may include:

- description of the transport stream (number of yearly loaded transport units per substance or category);
- description of transport units;
- description of the transport route;
- description of the number of accidents and degree of traffic in order to determine accident frequencies;
- description of ignition sources;
- properties of transported substances;
- terrain classification of the surroundings of transport route;
- meteorological data;
- population present in the surrounding area of transport route.

In order to evaluate risk about transport and using Geographical Information System potentiality, a management system could be adopted for creating a flexible instrument for planning at regional scale, thus combining state of the art guidelines and needs of the project.

The scale of the study area needs a practical instrument for managing a large volume of input.

A possible approach is illustrated in a very schematic block diagram in [Figure 1](#). Before the risk evaluation a full characterization of the transport flow may be done.

Phase 1 corresponds to this data characterization before starting to quantify risks. A data bank has been constructed for the four transport systems – road, rail, pipeline and inland waterways. In each data bank all data has been referred to the network with GIS.

Road and Rail have been characterized by the following indicators:

- indicators about incident;
- indicators about heavy and light traffic (not hazardous);
- indicators about hazardous transport (Fig. 2);
- indicators about population referred to the population within the sample area.

The approach has been guided by the need to characterize a the population within the sample area of the network for evaluating risk/s in a specific point of the road (rail).

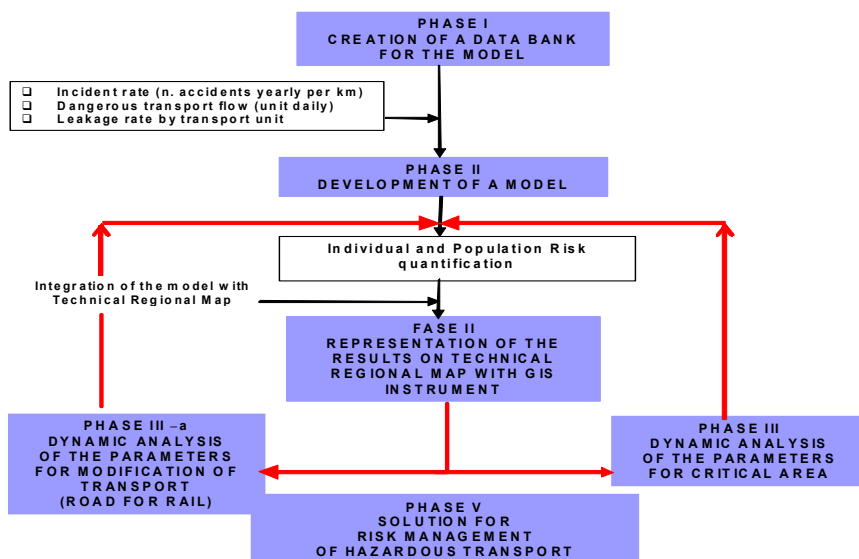


Figure 1. Schematic block diagram for description of project phase.

Then, in Phase III the model and maps have been integrated.

The result is a GIS software where, over Technical Regional Map, a simulation for a specific road/rail/pipeline sample area can be done.

In the Phase IV software has been implemented for dynamic analysis, such as the possibility to modify parameters in order to appreciate the sensitivity of the output to the risks.

For a specific area a variation can be done for:

- level of initial accident frequency;
- dangerous transport flow;
- type of leakage.

Phase IV is dynamic analysis in order to quantify the impact of a new road, or the effect of moving a certain quantity of dangerous substances from road to rail and vice versa.

Dynamic analysis is an instrument for evaluating possible solutions for reduction of the risk/s and the effects of future scenarios about variation of the traffic. In Italy it is predicted that transport will increase by 30%.

All these factors lead to Phase V, where solutions for risk management of hazardous materials have been investigated.

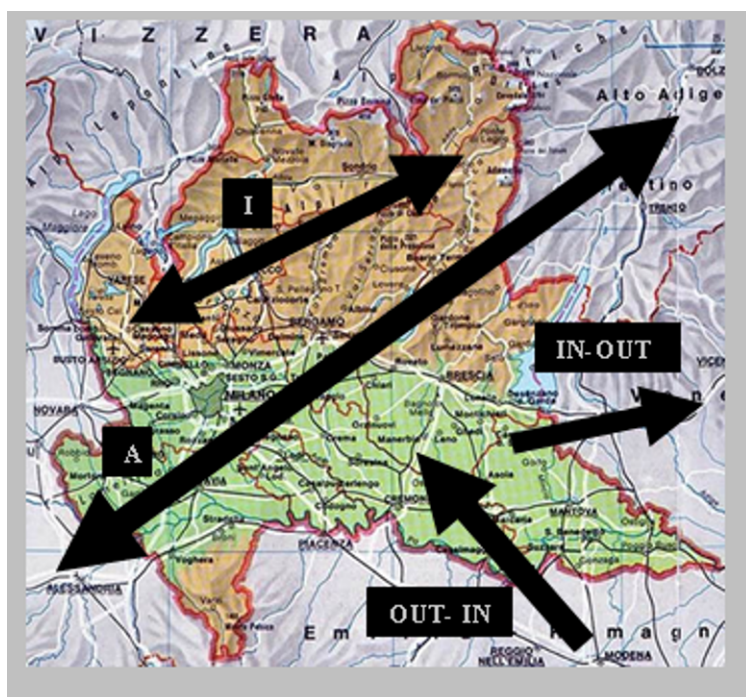


Figure 2. Different types of transportation for regional area.

3. Development of a Model for Quantifying Risk Due to Transportation of Dangerous Substances

The parameters for quantifying risk due to the transportation of dangerous materials adopted in this study are now discussed.

Let us define:

- λ = incident frequency of the selected sample area (number of accidents yearly per km);
- L = length of the sample area (km);
- NT = hazardous traffic flow (number of dangerous substances transported daily);
- PK = probability of release by transport unit;
- PS = probability of ignition of flammable substances;
- PJ = probability of certain meteorological data;
- PW = probability of terrain classification of the surrounding area of transport route (urban, rural and industrial);
- A = impact area (km^2);
- DW = population in the surroundings associated with selected sample area;
- FUG = human shelter factor for escape and protection.

About the first parameter, λ , the GIS data bank created for the project produces the number of accidents yearly per km for a selected sample area.

The hypothesis adopted for road transportation is that λ is the initial frequency of serious damage to vessel per unit distance.

The initial accident frequency is strongly dependent on local factors. For that reason each kilometre of the road system has been characterized by a specific initial frequency.

Rail and pipeline stream have been characterized by a constant incident rate per kilometre.

- length of the selected sample area (km)

Software is able to identify a certain length of the transport system on the Technical Map. The minimum unit is one kilometre.

- hazardous traffic flow (number of dangerous substances transported daily)

In the selected length a very important parameter is the number of journeys per unit time of the dangerous substances inherent in the sample area. A very long study has been carried out to determine the flow of dangerous substances in the investigated area.

The identification of those flows in the rail and pipeline stream has been done in great detail. In fact in those systems, the initial and final points of the transported quantity have simply been identified.

On the other hand, in road transport a more detailed study has been made.

Despite the complexity of the analysis, a GIS data bank about hazardous materials has been constructed concerning 9 Classes, defined by ADR, European agreement for the transportation of dangerous goods. For the sake of brevity, it was necessary to make a selection of certain dangerous substances.

- probability of release by transport unit PK.

The probability of a release by the vessel in the event of an accident to the specific transport unit is based on the following loss of containment events:

- release of complete inventory (20 m^3 for road vessel and 50 m^3 for rail);
- release of 50% of inventory;
- release of 10% of inventory.

A distinction has been made between pressurized and atmospheric containers. Let us define:

- $K = 0$ as no release;
- $K = 1$ as 10% of inventory;
- $K = 2$ as 50% of inventory;
- $K = 3$ as release of the complete inventory.

The probability adopted for road containers is reported in [Table 1](#).

- probability of ignition of flammable substances

TABLE 1. Probability of release for road transport unit.

PRESSURISED (%)	ATMOSPHERIC (%)
$P(K=0) = 99$	$P(K=0) = 90$
$P(K=1) = 0.9$	$P(K=1) = 9$
$P(K=2) = 0.07$	$P(K=2) = 0.7$
$P(K=3) = 0.03$	$P(K=3) = 0.3$

The events that have been considered are: toxic exposure, pool fire, jet fire, flash fire. For a given accident and for a given quantity released, a probability of

ignition may be adopted for flammable substance. This data has been quantified with an events tree.

- probability of certain meteorological data

Typical meteorological conditions have been investigated, in particular Pasquill Stability Class F and D.

Probability of terrain classification of the surroundings of the transport route (urban, rural and industrial)

A classification of the surroundings has been done for all transport networks. A GIS data bank, referring to the location, produces three probabilities, i.e. 30% arable land, 30% industrial area and 40% city and town.

- impact area (km²).

The physical effects of the considered events are calculated.

Population in the surrounding area associated with the examined sample area.

For all networks the number of people that could be exposed to the accident is calculated.

The criteria correspond to a selection of 1 kilometre up and down in the area of the potential release, where not only residential population but also potential human presence in schools, hospitals and offices are included.

- shelter factor for human presence.

In order to estimate physical effects to human beings and health, some shelter factors have been considered, i.e. the possibility of escaping and being protected.

In conclusion, the Frequency (event/year) and Impact (number of people affected) is calculated between these following expressions:

$$F(J, s, K, W, S) = \lambda * L * NT_s * PK * PS * PJ * PW \quad (1.1)$$

$$I = A * DW(W) * FAT(W) * (1 - FUG(J)) \quad (1.2)$$

Using a simple function for combining F and I, the Population Risk (affected yearly) takes on the following expression:

$$R(I, J, s, K, S, W) = F(J, s, K, W, S) * I(S, J, s, K, S, W) \quad (1.3)$$

For the sake of brevity, other details are omitted.

4. The Software: Technical Solution Adopted

The model and maps have been integrated. The result is a GIS software where, over Technical Regional Map, a simulation for a specific road/rail/pipeline sample area can be done.

Some images of the use of this instrument are presented in [Figures 3 and 4](#). The main characteristics are:

- it has been developed in an accessible format and is compatible with most commonly used operating systems;
- it is equipped with a user interface for the selection of road, rail and pipeline streams;
- the results will be geo-referenced into Technical Regional Map;
- consulting data bank associated with the selected sample area in particular all input described in the present paper.

An example of input and output is given for Tangenziale East of Milan in [Table 3](#), one of the sample area with more elevated concentration of traffic and incident per day in the whole of Europe.

TABLE 2. List of the input for Tangenziale East Milan.

INPUT	
<i>Highway A51</i>	
<i>Tangenziale East Milano</i>	
number of selected trait:	38
length of the selected trait (km)	38.02
Incident rate [vehicle /year per km]	11.5
Vehicle (average)	65244
Heavy vehicle (average)	8030
PW1 rural (average)	0
PW2 semi-rural (average)	0.15
PW3 city (average)	0.85
DW1 habitants /km2 (average)	0
DW2 habitants /km2 (average)	16219
DW3 habitants /km2 (average)	30627
Ammonia (vehicle /day)	30
LPG (vehicle /day)	43
Ethylene Dioxide (vehicle /day)	14
Gasoline (vehicle /day)	199
Diesel (vehicle /day)	199
Liquid Oxygen (vehicle /day)	16
Hydrofluoric Acid (vehicle /day)	16
Sulphuric Acid (vehicle /day)	11

The output concerned is presented in [Table 3](#):

TABLE 3. Risk for the population (people affected/year) for Highway A51 East Milan.

	REVERSIBLE	NOT REVERSIBLE	LETALITY
Urban areas	2.5E-1	1.5E-1	2.1E-2
Semi-rural	1.1E-1	3.3E-2	8.6E-3
All areas	3.5E-1	1.8E-1	3.E-2

Data in Table 3 represent specific risk about one highway.

The software produces a risk map for the whole road network, as shown in Figure 5.

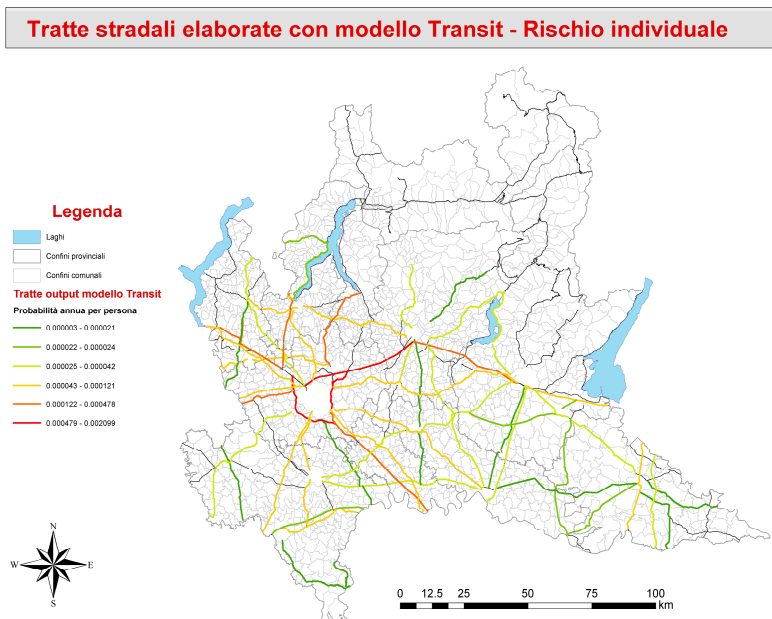


Figure 5. Population Risk for transportation road system.

5. Conclusions and Suggestions

The methodology chosen for this study allowed us to quantify risk for the transportation of dangerous materials. In this paper for the examined sample area a simplified example for the valuation of Individual and Population risk has been proposed.

This information data could be automatically updated by Public Authority, who in turn could create a data bank for territorial planning. This data could be a valid support for subjects with different competence and roles – such as Regions, Provinces and Local and Public authorities – especially when they have to handle the transportation of dangerous substances by road. Finally, the approach allows for:

- Identifying the sample areas with great risks in different transport streams.
- A possible planning instrument for Public Authority for evaluating the impacts of new roads, expansion of existing networks and for making planning forecasts for the next ten years (an increase of 30% has been estimated).

- A possible instrument for the decision maker to evaluate the reduction of risk/s, such as restrictions on time/frames or sample area deviations.

It is suggested that a Regional/National entity should be created for this data collection.

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PART III

CASE STUDY: DANGEROUS SUBSTANCES, MONITORING METHODOLOGIES AND INTEGRATED RISK

TRANSPORT OF PACKAGES WITH RADIOACTIVE MATERIAL AND SPENT HIGH ACTIVITY RADIOACTIVE SOURCES IN ALBANIA (A CASE STUDY)

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Abstract The transport of Radioactive Materials (RM) and Radioactive Wastes (RW) involves a potential radiological hazard. To ensure the safety of people, property and the environment, appropriate transport regulations for both domestic and international RM and RW are necessary. Transportation is an integral component of waste management and its safety is of as much public concern as the disposal system. When these materials are transported, they attract a great deal of public attention, and there is particular concern about shipments of spent nuclear fuel (SNF) and RW.

RW are produced throughout the world wherever radioactive materials are used and processed. Thus, generators of radioactive wastes include hospitals, industry, education institutions, power stations and fuel reprocessing facilities. Over 300 million packages of radioactive materials have been transported safely during the past year and it is estimated that during the next 15 years in the European Community between 50,000 and 100,000 m³ of Low Level Waste will be conditioned, transported and disposed of each year.

The total activity of radioactive substances transported in Albania (domestic and international) during 2007 has been some thousands Ci of unsealed and solid radioactive sources, mainly ^{99m}Tc; ¹³¹I, ⁶⁰Co, ¹³⁷Cs, ²⁴¹Am etc., by import-export procedures, and approximately over 850 type A and Type B packages.

A number of international bodies deal with the transport of RW and RM, issuing a large number of regulations, which have been recommended to member states as a basis for national regulations.

Since 2001, the Albanian Government has approved the regulation of Safety Transport of RM and RW in Albania, upgraded in 2006, which has substituted: 'The Regulation of Safety Transport of Radioactive Materials and Radiation

Protection by Ionizing Radiation Sources' (1971) and 'The Regulation of Safety Hazard Materials' (1997).

1. Current Status of Radioactive Waste (RW) Worldwide Transportation

A variety of RW are transported on a worldwide scale every year, including low-level and intermediate radioactive waste (LL/ILW), spent fuel (SF), high-level waste (HLW) resulting from spent fuel, and transuranic waste (TRU).

The annual amounts of LLW produced are, in Japan ($15,000\text{m}^3$), the UK ($10,000\text{m}^3$), France ($20,000\text{m}^3$) and USA ($70,000\text{m}^3$), respectively. The ILW also generated in the European community in significant quantities was estimated to amount to an additional $150,000\text{--}300,000\text{m}^3$.

In Europe HLW other than the spent fuel would require transportation, and the amounts involved are relatively small, so the UK had about 3500m^3 , and France about 5000m^3 of vitrified HLW in storage.

The modes of surface transportation (transport by air is very limited) typically include truck, rail and barge. In addition, seagoing vessels carry out spent fuel from Japan to Europe for reprocessing. The return voyages may transport plutonium for use as reactor fuel, and the waste from the reprocessing to Japan.

The formulation of rules for transport of radioactive materials has been necessary since 1950. On 1957 the International Atomic Energy Agency (IAEA), was established, and was charged with formulating the rules for transport of radioactive materials. The first regulation, designated *The rules for the safe transport of radioactive materials* (Safety Series No.6), was issued at the beginning of 1961. This regulation was revised in 1964, 1967, 1973 1979, 1985, 1990, 1996 and 2005.

The Safe Transport of Dangerous Goods by Air, 2nd Edition 1999; *International Maritime Dangerous Goods*, Code 1994; and *Dangerous Goods Regulations*, 41st Edition 2000, are some other international publications issued by the Advisory Commission on Safety Standards of IAEA, in cooperation with NUSSAC, RASSAC and WASSAC organizations. The transport regulation is accompanied by other publications of IAEA such as Safety Series No. 7, No. 37, No. 80, which explains all rules for the safe transport of radioactive materials.

The rules, which are recommended by IAEA, constitute the basis of regulations for the safe transport of dangerous materials on a national and international scale. However, the transport of radioactive material is often international. National regulations as well as the international modal regulations are based on the IAEA Regulations, applied for such transport.

Our Regulation for 'The Safe Transport of RM and RW in Albania' is formulated primarily according to Albanian national legal framework, as well as to ensure the safety of people and the environment properties.

2. Main Scope of the International Legislation and Regulations for Safe Transport of RM and RW

A number of international bodies deal with the transportation of radioactive materials and wastes, and the majority are sanctioned by or affiliated with the United Nations. Regulations promulgated by these agencies are recommended to member states as a basis for national regulations. The primary agency is the International Atomic Energy Agency (IAEA), while in the air transport mode, the International Civil Aviation Organization (ICAO) is active in regulating the transport of dangerous materials including radioactive materials. International Air Transport Association (IATA), made up of member air carriers, also publishes regulations for the air transport of restricted articles including radioactive materials.

The preparation and review of safety standards in radiation, transport and waste safety involves the IAEA Secretariat and member states via three safety standards committees – RASSC (radiation safety), WASSC (waste safety) and TRANSSC (transport safety).

International radiation safety standards cover a wide range of subjects in radiation, transport and waste safety, including the thematic areas opposite. Many member states have already benefited from IAEA appraisals of their safety infrastructure, improving progress towards a global framework for radiation, transport and waste safety.

Globally, there are several international agencies responsible for arranging the transport of dangerous and radioactive materials by road, rail, air, water and by all means such as truck, bus, automobile, ocean vessel, airplane, river barge, rail, car etc., except for the postal service.

Routing of radioactive materials and wastes is governed by routing rules; that is, requirements that direct, redirect, restrict, or delay the movement of radioactive materials.

1] The first rule is a general set of regulations that require carriers to consider such factors as population, accident rates, and transit time when choosing routes.

2] The second rule applies only to motor vehicles transporting large quantities of radioactive materials/wastes or spent fuel, and includes the preferred routes, the requirement of a routing plan, driver training certification and special vehicle for such transport. Also, under this rule, state agencies may designate alternative preferred routes for large quantities of radioactive materials.

3] Such regulations describe the rules for labeling of packages, and which kind of vehicle can be used for transport of RM and RW. Each package of radioactive material, unless expected, must be labeled on two opposite sides with a distinctive warning label bearing the unique trefoil symbol recommended by ICRP, or the orange placard indicating the UN number for the radioactive material transport shall be used for labeling purposes.

4] Each package, other than the exempted ones, will be assigned to one of the three following categories: I-White, II-Yellow and III-Yellow, taking into account both the surface radiation levels and the transport index. The values of the maximum radiation level on the external surface of the packages and of the transport index for mentioned categories are the same as the values recommended by IAEA documents and are shown in [table 1](#).

TABLE 1. Maximum radiation level on the external surface of the package.

Category	Maximum radiation level on the external surface of the Package	Transport Index
I - WHITE	> 0.005 mSv/h	0
II - YELLOW	0.05 – 0.5 mSv/h	0 to 1
III - YELLOW	0.5 – 2 mSv/h	1 to 10

5] The transport documentation for accompanying the shipment of radioactive materials is described in such regulations. This documentation follows the recommendations of IAEA, such as the proper shipping name, the name and symbol of each radionuclide, the activity of the radioactive material in the package, the category of the packages, the transport index, the identification mark of component authority approval certificate applicable to the shipment, etc.

6] Some other regulations describe the values of non-fixed contamination on the external surface of the packages, which shall be kept as low as practicable and shall not exceed 4 Bq/cm² for beta, gamma and low toxicity emitters and 0.4 Bq/cm² for all other alpha emitters. The contamination assessment shall include the package, the vehicle, the adjacent loading and unloading area, if replacement of the package is performed.

The radiation level for industrial type A and type B packages shall not exceed 2 mSv/h at any part of the external surface of the packages. The accumulation of the packages in a single vehicle/airplane shall be such that the radiation level under routine condition of the transport shall not exceed 2 mSv/h at any point and 0.1 mSv/h at 2 m from the external surface of the carrier.

Since radioactive wastes are produced in many different forms and volumes and with a range of specific activities. Several factors determine the different types of packages that are used for transport of the wastes: a] specific activity of the waste; b] quantity of the radionuclides and c] the forms of the radionuclides. The main types of packages are referred to as *limited-quantity*, *low-specific activity (LSA)*, *type A* and *type B*. In most current regulations, limiting values A_1 (for radionuclides in special forms) and A_2 (for normal form) specify the maximum activity of the radionuclide that may be transported in a type A package. [Table 2](#) gives examples of A_1 and A_2 values.

TABLE 2. Type A packages quantity limits for selected radionuclides.

Radionuclide	Atomic number	A ₁ (special form)	A ₂ (normal form)
		Ci	Ci
14C	Carbon (6)	1000	60
137Cs	Cesium (55)	30	10
235U	Uranium (92)	100	0.2
226Ra	Radium (88)	10	0,05
201Pb	Lead (82)	20	20

Quantities exceeding these limits for type A packages require Type B packaging. Quantities greater than 3000 times A₁ or A₂ are called *high-way-controlled quantities* and are subject to additional regulations. An example of Type B packaging of transport of radioactive waste.

1. *Low-level radioactive waste* can be shipped in LSA or type A packages, although it is sometimes shipped in Type B packages.
2. *LSA packaging of radioactive waste* includes contaminated clothes, cleaning clothes and hardware from nuclear power plants.
3. *Type A packaging* must meet radiation containment of wastes from nuclear power plant filter resins, irradiated hardware and highly contaminated clothing.
4. *Type B packaging* is used for the shipment of type B solid, non-fissile, irradiated and contaminated hardware and neutron source components.
5. *High-level radioactive waste* and spent nuclear fuel are typically shipped in type B packages. Shipping casks for spent nuclear fuel are used frequently from other countries.
6. *Shippers of fissile radioactive materials* must take into account packaging and shipping requirements to ensure the absence of nuclear criticality. The design of such packaging, the transport index (TI) to be assigned, and any special procedures for packaging are all covered by special regulations of the countries which generate such waste.
7. *Highway-route-controlled* quantities packages are subject to specific routing controls that apply to the highway carrier. The carrier must operate on preferred routes that are in conformity with regulations, and need to report to the shipper the route used in making the shipment.

All activities have some associated risks, including the transport of radioactive materials, radioactive waste and spent fuel. Risks from transportation can be considered under two conditions: *normal operations* and *accident conditions*.

- A. Normal transport operations are those that don't involve accidents; hence the only hazard arising from these operations is radiation exposure resulting from contents and from any contamination on the outside of the package.

A survey in the UK by NRPB indicated that the collective radiation dose to the public from gamma radiation due the transport of Magnox fuel (1000MTU/year) amounts to about 2 person-rem/year, and the annual collective dose equivalent to all railway workers involved in the transport of spent fuel in UK is about 0.5 person-rem, approximately the annual collective dose to two people from natural radiation.

- B. The events usually regarded as the precursors to serious accidents to packages are impact, fire, and immersion in water, or some combination of these events. Usually, the standards from IAEA-regulations, which provide a higher degree of safety to the public and environment during the transport of hazard materials, are foreseen, and in such cases the probability is estimated to be no greater than two occurrences in 1 million rail transport accidents.

3. Transport of Spent Radiation Source of Cobalt-therapy ^{60}Co

The transport of the revolving head with cobalt ^{60}Co spent radiation source to the radioactive waste laboratory in INP was made in accordance with the recommendations of IAEA and national regulations for transport of radioactive material.

The transport was performed on 28th December 2006, by special truck, when the source activity was calculated and measured, finding the $A \approx 67\text{TBq}$. The packaging consists as a solid metallic construction, including the cobalt ^{60}Co source within the lead shielding. The external dimensions of package were 1156 mm high by 1010 mm long by 900 mm wide. The maximum gross mass was 1500 kg without the stainless steel ends and 1700 kg with stainless steel ends.

This type B (U) package was designed to withstand normal transport conditions. The shape, size and weight of the inner packaging component (head of the source) determine the best material to be used. The prime consideration is to ensure the minimum movement of the inner packaging, within the outer packaging, in order to comply with the regulatory requirements regarding the minimal increase of the radiation dose rate on the surface/and 1 m distance.

We have affixed the placards with radioactive trefoil signs in four sides of the package, together with the index transport $\text{TI}=0-1$ (the maximum measured dose rate $\approx 62, 9 \mu\text{Sv/h}$) and category II yellow, during transport to disposal repository in INP.

A technique for the measurement of the source radioactivity and contamination of the operational tools was organized using: direct measurement, using the Field-Spec apparatus positioned near contact with the surface of objects. Indirect measurements are taken using a paper smear to swipe a known area of objects in order to assess whether loose contamination is present. The competent authority arranged the assessment of radiation doses to persons, driver and accompanying

assistant, during transport up to INP destination. The inspector of state policy had the truck escorted to the INP destination.

4. Conclusions

1. The International Atomic Energy Agency (IAEA), as the main organization in the world for the use of '*Atom for Peace*' in collaboration with other organizations like: the International Civil Aviation Organization (ICAO) and Air Transport Association (IATA), has formulated and adapted the Legislation & Regulation for Safe Transport of RM & RAW ensuring the safety of people, environment protection and control.
2. New Albanian Radiological Protection Act, adopted after ICRP Publication 60, has obligated the National Radiation Protection Commission (NRPC) with the rights to approve the regulations for the different aspects of radiation safety, including the safe transport of radioactive materials and wastes, in Albanian territory.
3. In Albania in fact a limited activity exists related to the transport of dangerous and hazardous materials, but underlines the fact that our regulations have established standards of safety to the people and environment, providing an acceptable radiation level, and they are considering a new development in the safe transport procedures for transportation of the radioactive materials and waste.

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CRISIS MANAGEMENT DURING ACCIDENT WITH HIGH RADIOACTIVE SOURCES IN ALBANIA

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Abstract CANP and RPO have established a system of regulations and guide in order that arrangements for preparedness and response are in place for the on-site area for any practice or source that could necessitate an emergency intervention that meets international requirements.

Both these institutions have in place a system to ensure that emergency arrangements are integrated with those of other response organizations as appropriate before the commencement of any operation, and that such emergency arrangements provide a reasonable assurance of an effective response in the case of a nuclear/radiological emergency.

Integrated National Emergency response plan for radiation emergencies is communicated to all relevant parties. Detailed response plans and procedures are updated, consistent with the national emergency response plan. In the plan are defined the national operational intervention levels consistent with international guidance.

CANP is responsible for measurements, techniques and samples collection in case of any emergency situation. This institution is also responsible for a training centre for such objectives on a national scale, which every two years organizes national training courses in the above-mentioned issues. The national emergency plan was rehearsed and tested from time to time by responsible organizations in Albania.

1. Introduction

The conventions on early notification of a nuclear accident or radiological emergency are the prime legal instruments that establish an international framework to facilitate the exchange of information and the prompt provision of

assistance in the event of a nuclear accident or radiological emergency, with the aim of the minimizing the consequences.

The International Atomic Energy Agency (IAEA) has specific functions allocated to it under these Conventions, where some other important organizations such as WHO, WMO and FAO are full parties.

Since 1989, the arrangements between these organizations for facilitating the practical implementation of those articles of the two Conventions, which are operational, have been documented in the Emergency Notification and Assistance Technical Operational Manual. Moreover, some regional organizations are party to arrangements among states. There also exist bilateral arrangements between some international organizations that have relevance to preparedness and response arrangements.

It is recognized by the organizations responsible for accident response that good planning in advance of an emergency can substantially improve the response. Moreover, one of the most important features of the emergency response plan is clearly the responsibility of the authorities.

2. The Structure for National Agencies' Response to Emergency Situation in Albania

In Albania, no research reactor or nuclear power plant is in operation, but on the other hand, it is not far away from countries that have such reactors, creating the probability that the country could be affected by a nuclear or radiological emergency.

The experience with ionizing radiation sources in Albania, as well as in other countries, has shown the necessity for strict application of working rules with such high-level activity radioactive sources, in order to avoid the probability of incident/accident. The level of response to a specific emergency will be based on the type and/or amount of the radioactive material involved, the location of the emergency, the impact on or the potential for impact on the public, environment, and the size of the affected area.

The IAEA has categorized all probable nuclear/radiological accidents in five categories, and considering the ionizing radiation sources which are used in Albania, as well as its geographical position, Albania is included in IIIrd, IVth and Vth accident categories.

Based on the above-mentioned information, as well as the necessity for the countries, including Albanian territory, to use the **Spent High Activity Radiation Sources (SHARS)** or countries which are in the vicinity of nuclear power plants, it was foreseen that a national nuclear/radiological/emergency plan should be established in order to create and organize the necessary infrastructure to coordinate emergency actions if such events were to happen in Albania or other neighbouring countries.

Since 2000, the Albanian institutions and organizations are included in this process to fulfil such objectives in accordance with the emergency management plan of the international organizations, which are: **a]** legal provisions for such actions and activities; **b]** bases of planning; **c]** organization and functional responsibilities; **d]** emergency and protection conditions and operations; **e]** operational concepts; **f]** emergency teams and chairmen; **g]** training, workshop and operational exercises.

In November 1995, the Albanian Parliament approved the law 8025, 'The Radiological Protection Act', and very soon, the Albanian Radiation protection Commission (ARPC) and Radiation Protection Office (January 1996) were established as the competent authority and executive organs.

Already, the scientific life was developed as a result of the qualitative progress of the above-mentioned activities in these fields. The monitoring Networks Control of the Occupational and Medical Exposures were widespread in the whole country. Also, the activities of calibration of the dosimetric apparatus laboratory, the radioactive waste management laboratory and the temporary interim storage facility are established as consolidated programmes in Albania. The emergency preparedness and response network system is totally functional in the event of any probable nuclear/radiological accident, covering the whole Albanian territory.

Planning the countermeasures towards the prevention of nuclear/radiological accident is based on the determination of responsibilities to the users of radioactive sources, to the competent authority, as well as to other organizations which are responsible for applying the emergency plan.

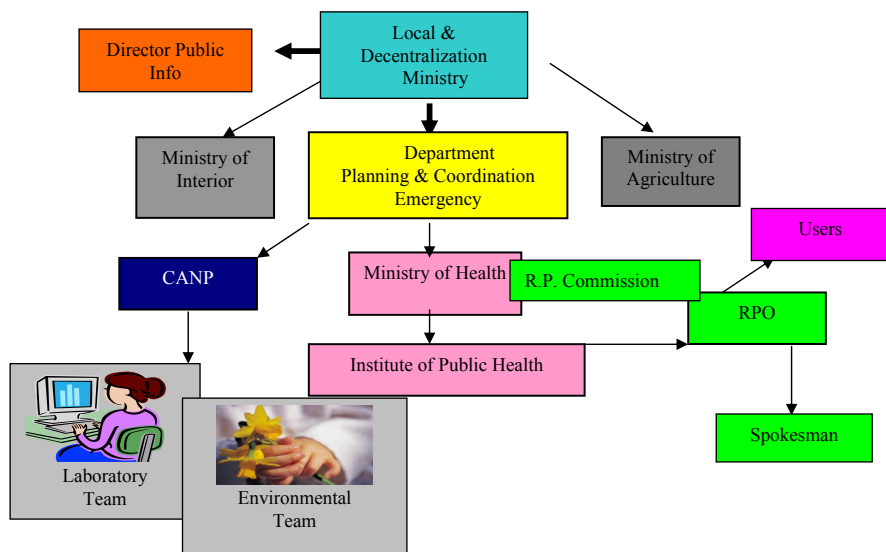
The main procedures of response toward radiological emergency are composed, and two emergency teams are established, one of which investigates the conditions of monitoring these emergencies on site, and the other one under laboratory conditions.

The CANP as training centre has held some regional training courses for the personnel, which are included in radiological emergency programmes, carrying out four national seminars on 2001, 2003, 2005 and 2007, with the participation of the staff from the Local and De-centralized Ministry, 12 mini-municipalities and General Custom Directory, with main topic: Investigation/Detection and Discovery of lost radioactive sources.

The National Radiation Protection Commission, in the meeting dated February 2005, made the decision to review the National Emergency Plan as a result of the new laws, amendments for the re-organization of the emergency infrastructure in our country, and the management of the emergency situation based on contemporary concepts. The working group established for such purposes has finished the new draft of the national project for management of radiological emergencies. Based on this draft project, the Department of Planning and Coordinating of the Emergencies (DPCE) near the Local and De-centralization Ministry is the leader of the structures for management of the emergency situation including the radiological emergency in the whole country.

In a radiological emergency situation, this department will be in contact with ARPC and CANP, in order to monitor the radiological situation through the monitoring network, as well as by the emergency teams.

The CANP carries out its tasks in the actual emergency plan through the department of radiological protection and performs the following tasks: 1] to ensure technical backup for radiation protection staff involved in the management of a radiological emergency, as well as to the public and environment affected by the harmful consequences of the emergency situation; 2] performs monitoring of the emergencies through the national network, as well as the monitoring by its emergency teams on site and in the laboratory, and proposes the necessary counter-measures to confront the consequences caused by the accident during the development of the emergency situation; c] carries out the measurement of samples of foodstuff products, as well as the environmental samples sent in to CANP by different organizations, giving recommendations for the opportunity of their use; d] gives technical assistance to users of the radioactive sources in connection with the incidents, avoiding the consequences of the accident, as well as designing their emergency plan, ensuring that their staff are qualified to meet the problems related with management of the radiological emergencies. The organizational structure of the emergency situation is shown in diagram 1.



3. Conclusions

1] The Albanian institutional parties to the agreement on assistance in the case of a nuclear or radiological emergency, have to cooperate among themselves and with other national/international organizations in facilitating the prompt provision of assistance in the event of a nuclear accident or radiological emergency, in minimizing the consequences and in protecting life, property and environment from the effects of any radioactive releases.

2] The emergency action plan is developed by DPCE and is coordinated with other actions/operations of the national/international institutions, including all technical, financial, organizational and logistical aspects, for minimization of the consequences of an accident.

3] Radiation monitoring and radionuclide identification activities include on site gamma spectrometry or analyses of lab samples, environmental and source monitoring, sampling and sample handling and reporting of measurement data, in order to minimize as much as possible the consequences of the nuclear/radiological accident.

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EMERGENCY RESPONSE IN CASE OF AN ACCIDENT DURING TRANSPORT OF RADIOACTIVE MATERIALS

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Abstract Transport of radioactive materials is a very important problem considering the potential risks and radiological consequences associated with carrying out this activity. Transport of large radioactive sources often involves movement through the public domain with minimal physical protection. Ukraine has established an emergency preparedness and response system in the event of nuclear/radiation accidents and incidents in Ukraine. This system is completely applicable to spent fuel and radwaste management facilities, as well as to the transportation of ionising radiation sources and radioactive materials. In the past few years in Ukraine much effort has gone into the field of emergency preparedness and response to an accident involving the transportation of radioactive materials. The feedback experience gained after the Chernobyl accident has been used to improve knowledge of the effects following a radioactive exposure.

1. Introduction

Radioactive materials (RAM) are transported in connection with their use in energy, industry, medicine, radioactive waste management and nuclear fuel across Ukraine. Transport of radioactive materials is a very important problem considering the potential risks and radiological consequences on carrying out this activity. Transport of large radioactive sources often involves movement through the public domain with minimal physical protection. These cargoes should be formally recognized as potential weapons of mass radiological contamination. Ukraine has established an emergency preparedness and response system in the event of nuclear/radiation accidents and incidents in Ukraine. This system is completely applicable to spent fuel and radwaste management facilities, as well as to transportation of ionising radiation sources and radioactive materials. In the past few years in Ukraine much effort has gone into the field of emergency preparedness and response to an accident involving the transportation of radioactive materials. It should be recognized that the emergency planning and preparedness

elements for responding to transport-related accidents involving radioactive material are, to a great extent, similar to those for other dangerous goods.

A nuclear accident during the transportation of radioactive material means an event causing loss of control of radioactive material, resulting in, or which might result in, a radiation dose to people and environment which exceeds the allowable limits determined by regulations and standards of safety. The accident zone is the area where specific measures require to be conducted in connection with this event. The main cause of the emergency during radioactive material transportation is transport facility failure, poor organizational management and human factors. The feedback experience gained after the Chernobyl accident has been used to improve knowledge of the effects following a radioactive exposure. For many years, the IEG NAS and MES of Ukraine have developed projects regarding the planning and implementation of the decontamination/remediation activities in the different compartments of the environment, following an accidental exposure to radioactive materials.

2. Event Classification

The hazards of radioactive material transport may be characterized by two distinct conditions of transport and the subsequent risks associated with such transport: i.e., risks associated with incident-free transport as well as those resulting from possible incidents and accidents and the potential to affect people, property, and the environment. The IAEA Transport Regulations establish safety standards that provide an acceptable level of control of the radiation, criticality and thermal hazards to persons, property and the environment that are associated with the transport of RAM and utilise the safety principles set forth in the International Basic Safety Standards and Fundamentals [1-4]. Ukrainian authorities have signed a number of international agreements that contain regulations relative to actions in case of emergency and information about them.

According to the legislation, the activity related to radioactive materials transportation is subject to State regulation. The Laws of Ukraine 'On Use of Nuclear Power and Radiation Safety' and 'On Permissive (licensing) Activity in the Area of Nuclear Energy Use' envisage licensing of the activity related to radioactive materials transportation [5, 6]. According to the Decree of the Cabinet of Ministers of Ukraine 'On approval of the Procedure for licensing certain types of activity in the area of use of nuclear power' of 6 December, 2000, No. 1782, these Laws of Ukraine set the legal and organizational principles of the licensing activity to transportation of radioactive material into their mode-specific regulations: Safety Guides: «Safety Regulations for Storage and Transportation of Nuclear Fuel at Nuclear Power Facilities» (PNAE G-14-029-91) [7]; NP 306.6.124-2006. Rules and nuclear and radiation safety at transportation of radioactive materials (Ukrainian acronym – PBPRM-2006) [8].

Today about 40 enterprises and organizations hold licenses for activities related to radioactive materials transportation. In Ukraine, radioactive material/waste is usually transported by road, while spent nuclear fuel (SNF) is transported by rail, though there are also other transport facilities. There are transportation rules and requirements for each kind of transport facility. Assessment and rating of transport events within the Ukrainian radioactive material transport event has essentially been based on the scale for radioactive material transport events developed for the IAEA's Transport Event Database 'EVTRAM' [4]. The objective of the database is to collect information that is useful in determining the effectiveness of the Transport Regulations, and thereby allow full use to be made of any lessons learned as a result of events. Thus, reportable events are those in which the safety functions of a package have been disturbed, possibly affecting people, property and the environment. This includes any event that happens between the time that the package is presented for transport and the time it is accepted by the consignee. An event that occurs during or after the package is loaded on the vehicle should be included. Events that happen during in-transit storage and handling are also to be included. If, on opening the package, significant discrepancies are found in the form of missing components, internal leakage, etc., this should be reported. Events involving portable equipment that contain radioactive material, such as radiography devices and density gauges being transported to and from the job site, should also be included. The 'EVTRAM' severity scale categorizes transport events into seven broad severity classes (level 1–7) based on the type and magnitude of the radiological consequences and/or the effort required to restore control, if it has been lost (e.g. through recovery/remedial measures):

Level	Description
7	Major accident
6	Severe accident
5	Accident with significant radiological consequences
4	Accident with appreciable radiological consequences
3	Accident with limited radiological consequences
2	Incident with complications, affecting safety functions, but no release
1	Incident resulting in some disruption of normal transport, without affecting safety functions
(0)	Non-incident (e.g. 'false alarm')

The characterization and description of the type and nature of transport events involving radioactive material shipments has been based on the classification scheme developed for the IAEA Transport Event Database 'EVTRAM'. The IAEA's 'EVTRAM' database divides abnormal occurrences and irregularities during transport into seven broad categories including the following:

1 – Unlawful interference:	theft, malevolent acts (e.g. sabotage)
2 – Documents, marking, labelling:	improper/absent documents etc.
3 – Preparation for shipment:	undeclared material, wrong package etc.
4 – Handling during transport:	package dropped, package crushed, package damaged, wet package etc.
5 – Loss of control of package:	package lost, package misdirected etc.
6 – External influences:	conveyance in accident, fire
7 – Unspecified:	unknown, others

Clearly the nature, characteristics and effects of accidents involving radioactive material depend on many factors. These include the type of package, the physical and chemical form of the material, its radiotoxicity, the amount of radioactive material contents, the mode of transport, and the severity of the accident as it affects the integrity of the package.

Radioactive material transport operations involve usually a wide range of activities and operations including, for example, preparation of the radioactive material package by the consignor, loading/unloading operations, carriage in the public domain, in-transit storage, intra-/intermodal transfer and delivery of loads of radioactive material packages to the consignee at the final destination. Abnormal occurrences and irregularities (events) can occur at each of these stages of transport.

The event details recorded in the database are broadly compatible with the IAEA Transport Event Database EVTRAM and generally include – where available – the following information:

- date of event
- location of event or event discovery
- mode of transport
- type of material involved
- stage of transport
- description of the event
- type and severity of the adverse consequences
- primary cause of the event
- emergency response activities.

A structured analysis of the type, severity and frequency of transport accidents involving RAM shipments should address the following issues:

- accident assessment approaches and related data requirements
- accident identification
- accident severity categorization
- accident event frequency estimation
- reliability of accident assessment model predictions.

Accidents during spent nuclear fuel (SNF) transportation are classified by level of danger, pursuant to the Safety Assessment Report for that transportation. There are three categories of possible accidents regarding SNF transportation:

Level 1 accident:

- the packages suffered mechanical impacts without visible damages;
- the packages suffered heat impact due to fire outside the transporting vehicles.

Accidents of this type present no risk for population and environment, as the containers passed all tests under IAEA rules and meet the radiation safety standards.

Level 2 accident:

- the packages suffered mechanical impacts and sustained significant damages;
- the packages suffered fire and sustained visible surface burns.

The increased radiation level due to these accidents does not exceed the emergency limits defined by IAEA rules.

Level 3 accident:

- the package is partially or totally destroyed, the radiation level and release of radioactive products from it exceed the emergency limits defined by IAEA rules.

The assumption in case of Level 3 accidents is that 10% of fuel elements occurred to be with leakages and the container is totally unsealed. At this assumption 4.44×10^{14} Bq of Kr-85, 2.13×10^{10} Bq of Cs-134 and 2.13×10^{10} Bq of Cs-137 activity will be released into the environment.

3. Emergency Preparedness

Planning of off-site emergency measures, as well as other emergency preparedness and response measures, is incorporated in the Unified State System for Prevention and Response to Man-Induced and Natural Emergencies (USSE). With the purpose of further improvement of cooperation between the Ministry of Emergencies and the SNRCU in the area of notifiable emergencies, the Procedure for interaction between the SNRCU and the Ministry of Emergencies in the above-mentioned area was updated and approved by the Joint Order in 2006. This procedure is developed pursuant to the Resolution of the Cabinet of Ministers of Ukraine 'On Designation of the National Competent Authorities on Fulfilling the Obligations under International Conventions in the Area of Nuclear Energy Use'.

With the purpose of improving the emergency preparedness and response system and working out actions in case of radiation incidents caused by terrorist acts, emergency exercises were conducted with the participation of the Ministry of Emergencies of Ukraine. According to the plan of the Ministry of Emergencies of

Ukraine, the annual drills and exercises are conducted in the territories that may fall within areas of potential radioactive contamination in case of accident. The purpose of such exercises is to verify the efficiency of the plans for public protection in case of radiation accidents. Regulation No. 431/10711, named «Provisions on Planning of Measures and Actions in the Event of Accidents in Radioactive Material Transport» came into force on 1 June 2005.

The Unified State System for Prevention and Response to Man-Induced and Natural Emergencies consists of four permanent-basis functional and territorial subsystems and is divided into four levels – national, regional, local and enterprise. USSE functional subsystems are established by ministries and other central executive bodies to organize activities intended to prevent emergencies and protect population and territories against their consequences. In order to assure preparedness of USSE functional and regional subsystems for effective and quick response to emergencies, governmental bodies responsible for subsystems of all levels develop individual plans for response to emergencies that are most likely to occur in a particular territory, branch or enterprise. Development of individual plans is required by the National Plan for Response to Emergencies elaborated and approved by Resolution of the Cabinet of Ministers of Ukraine No. 1567 of 16 November 2001.

In 2008, according to the requirements of the ‘Radiation Accident Response Plan’, the Ministry of Emergencies approved the ‘Model Response Plan to Radiation Accidents of Territorial Subsystems of the Unified State System of Civil Protection of Population and Territories’, all or part of which territory belongs to NPP Observation Zone. The objective of the model plan is to provide territorial sub-systems at regional and local level with the same requirements to the structure, content and format of the response plans that correspond to the requirements of the legislation in force in the area of civil protection and radiation safety.

Emergency plans developed in order to respond to transport accidents involving packages containing radioactive material. Consignors and carriers developed their specific emergency plans and preparedness procedures. The main plan needs to be flexible to cope with a wide variety of accidents.

The plan covers:

- The planning basis;
- Responsibilities, capabilities, and duties of the organizations involved;
- Procedures for alerting and notifying key organizations and persons;
- Methods for warning and advising the public;
- Intervention levels for exposure and contamination;
- Protective measures;
- Procedures for response actions;
- Resources, and medical and public health support;
- Procedures for training, exercises and updating plans; and
- Public information.

The emergency plan covers the route for road, water and railway transport schemes. In case of general radiation accident, the Ukrainian national emergency plan will be actuated. In case of general radiation accident involving foreign territories the emergency plans of the affected countries will be actuated too. The plan defines the activities of the accompanying and emergency centre teams, further instructions aiming at limitation and elimination of the consequences if an accident occurring during transportation. The emergency plan is developed in accordance with the Ukrainian legislation and international conventions; it is agreed with the due state authorities, including SNRCU, Ministry of Energy of Ukraine, Ministry of Health of Ukraine, Ministry of Internal Affairs of Ukraine, Security Service or is approved by the Executive Director of NPP.

4. Organization of the Emergency Response Actions

Since the type of emergency plans for responding to transport accidents involving radioactive material (designated as Class 7) are often the same in structure as the plans for responding to accidents involving other dangerous goods (Classes 1–6, and 8 and 9), many of the same organizations will be involved and many of the same actions will be required. It is therefore preferable, wherever possible, to integrate the transport emergency plans for radioactive material with the plans for responding to accidents involving other dangerous goods.

The organization of the emergency actions in response to nuclear events is divided into three types depending on the contamination areas [9, 10]:

Local radiation accident – the radiation level is increased only around the container or the platform of the vehicle;

Medium-sized accident – radioactive contamination within the whole vehicle or on the road;

General radiation accident – radioactive contamination of the river or areas outside the roads with consequences to the population and environment and possible transmission to other countries.

The basic steps in case of an emergency situation to ensure people's safety by:

- defining and marking the contaminated areas through detection of leakage location by radiometric means;
- dosimetric measurements and limitation of the access to the contaminated areas;
- providing dosimetric pass control.

Elimination of the accident:

- defining measures for eliminating the cause of the activity leakage;
- cleaning and decontamination of the contaminated area;
- decontamination of the equipment and tools used, as well as the personnel;
- collecting and storage of the wastes from the accident.

Continuous dosimetric control of all activities and control of the personnel radiation exposures is to be assured through all the processes. Information regarding the emergency response actions is regularly submitted to the emergency centre. The rescue activities have priority over all other activities related to eliminating or limiting the accident consequences. In transport accidents where large numbers of members of the public are exposed to a release to the atmosphere, such as in an urban area of high population density, the situation would be more serious than that considered above. In such a situation, prompt emergency action would be impractical. Radioactive materials are often in the public domain during transport and accidents/incidents may affect individuals or their property. The radiological consequences are most likely to be trivial, but the public concern is likely to be substantial.

The NAEK Energoatom emergency preparedness and response system is included in the USSE functional subsystem «Nuclear Energy and Fuel and Energy Complex», which is within the competence of the Ministry for Fuel and Energy of Ukraine. The functional subsystem includes the main and backup emergency centres of the NAEK Energoatom, as well as a separate subdivision: The Technical Centre for Emergencies is located in the village of Bilogorodka, Kyiv region. Emergency and technical centres (SS ETC), depending on the radiation accident scale, the following measures directed at its liquidation are suggested [11]:

- formation of working teams for liquidation of the radiation accident consequences;
- organization of radiation control;
- provision of service kit;
- provision of means for accident liquidation;
- localization of the radiation accident site aimed at carrying out of rehabilitation works;
- decontamination of the area, carriers, loads, equipment and overalls;
- collection and removal of radioactive matter;
- investigation of the cause of the accident and execution of documents concerning the accident.

The main goals of SS ETC: – preparedness of Ukraine for quick and effective actions in case of accidents at nuclear power and industrial enterprises in accordance with the international obligations of Ukraine and IAEA requirements for the creation of a national system of nuclear accident management – post-accident activity planning in case of transport accidents during radiation dangerous material transportation.

The principal tasks:

- management, preparation and performance of emergency work on post-accident clean-up;
- engineer and radiation survey of emergency objects;

- forecasting of radiation situation in emergency area and propositions on mitigation of negative accident results for population and environment;
- decontamination of premises, equipment, as well as dust reduction while performing.

In case of an accident (crash, explosion or ignition of packages and vehicles), the radiation hazard may appear as a result of complete or partial destruction of the container and fallout of radioactive matter. It may cause an increase of the dose rate, and the radioactive matter may penetrate the environment. In case of radiation hazard when it is impossible to estimate the degree of destruction of the packages, the following measures are required to be carried out:

- estimate the radiation situation, determine the limits of the hazardous area and fence it with warning signs, estimate contamination levels of the site, vehicles and loads;
- find people exposed to radiation and send them for medical examination and cleansing;
- start liquidation of the radiation accident consequences.

The contaminated areas, large-size objects and vehicles are decontaminated at the radiation accident site. The other contaminated objects, things and equipment as well as waste from decontamination are packed and transported to decontamination or disposal sites.

Progress has been achieved in developing the system for emergency preparedness and response in the event of nuclear and radiation accidents over the last year in Ukraine. The emergency response plans are tested on a regular basis and the emergency preparedness system is verified for actions in emergencies.

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SOME ASPECTS RELATED TO CONTROL OF NUCLEAR MATERIALS – INTERNAL AND TRANSFRONTIER CASES – IN ROMANIA

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Abstract The paper is focused mainly on aspects related to the activity of the National Institute of Physics and Nuclear Engineering 'Horia Hulubei' (NIPNE-HH), the main and oldest nuclear research centre in Romania (founded in 1956). NIPNE-HH has the first research nuclear reactor in Eastern Europe – Russian type VVRS (1956), shut down in 1998 and in the last years involved in a decommissioning process. The aspects related to the security of the fuel bars inside NIPNE-HH and of their transport across country are presented. The potential danger of the so-called 'historical' radioactive sources (remnants from old research facilities, medical and industrial radioactive sources manufactured in NIPNE-HH and recuperated from the users, etc) located in special deposits – e.g. Magurele ancient military fort, one million Ci – is also discussed. The necessity of psychological control – each year – of the staff authorized to handle the radioactive materials is obvious, especially to avoid the development of a Frustration Psychology (family and job-related problems). Also the necessity of a complete inventory of the radioactive materials in all the nuclear objectives and of its annual verification is requested. Finally, some events are presented relating to illicit trafficking in radioactive materials in the last 15 years on Romanian territory. To manage such situations, in 2000 a special Nuclear Police unit was created, equipped with dosimetric-detection systems, handling and decontamination equipment, and dedicated transport facilities.

1. Bucharest VVRS Reactor's Enriched Uranium Fuel Case

The paper focuses mainly on aspects related to the activity of the National Institute of Physics and Nuclear Engineering 'Horia Hulubei' (NIPNE-HH), the main and oldest nuclear research centre in Romania (founded in 1956). NIPNE-HH had the first research nuclear reactor in Eastern Europe – Russian type VVRS

(1956), shut down in 1998 and in the last years involved in a decommissioning process [1]. Unfortunately, the nuclear fuel of this reactor is included in so-called 'Cold War remnants'. The National Nuclear Security Administration (NNSA), an arm of the US Department of Energy, estimates that research facilities around the world contain some 2,000 kilograms of highly enriched uranium – enough to make 80 nuclear bombs. Most of the material is left over from the Cold War, when the United States and the Soviet Union provided some client states with equipment and material for research reactors. Other significant quantities were supplied by the United Kingdom and France, or in the case of South Africa, were enriched domestically. The highly enriched form of the metal – the result of a complex and costly engineering process that only a handful of nations have mastered – was needed at the time to achieve the energy or 'flux' required to power reactors [2]. With technological advances since then, however, low enriched uranium – which is ill suited for a nuclear weapon – can now accomplish the same goal. Many of these sites, however, are not well protected and considered prime targets for theft or sabotage. A US-financed programme to remove the bomb-grade material and have it downgraded began a decade ago under the Clinton administration. Since then, highly enriched uranium has been cleaned out of 14 countries and returned to either the United States or Russia. In addition, a series of reactors around the world have been converted from high to low enriched fuel; several more, including one at the Massachusetts Institute of Technology, are slated for conversion in the coming years. A crude nuclear bomb can be made from as little as 33 pounds of highly enriched uranium. President Barack Obama earlier this year, 2009, outlined a U.S. commitment to speed up the movement of vulnerable nuclear material from research reactors around the world.

In the case of Bucharest reactor, the unused (not 'burnt') Uranium fuel bars (provided by Russia years ago) were transported back to Russia in 2003 within the framework of a USA–Russia–Romania agreement, as part of the USA–Russia nuclear nonproliferation programme.

The used ('burnt') fuel (about 20 kg, 30% enriched) is still in the Institute, but it will also be transported to Russia for reprocessing this summer (total cost 4,200,000 USD) within the framework of the Global Threat Reduction Initiative, proposed by USA and Russian Federation under IAEA supervision, which includes accelerating the ongoing repatriation of Russian origin, high-enriched uranium fuel and spent nuclear fuel of both Russian and U.S. origin. The permanent deposit cost in Russia for this 'burnt' fuel is 780,000 USD. The security of the fuel bars inside NIPNE-HH and of their transports crossing the country is in charge of a specialized military (Gendarmerie) unit. The access in the Institute and within its buildings is controlled by electronic and video systems 24 hours a day. Russia designed special equipment to fly the radioactive spent fuel out of Romania, including 5-tonne casks that have undergone extensive testing to ensure they would survive a crash. When the loading is completed, drivers will take the spent

fuel rods along secret routes to the airport, to a giant – specially prepared – Russian Antonov 224 cargo plane. The convoy will be protected by Romania's Gendarmerie military police. The danger is very high, because if the material is released, either from an attack or an accident, much of the city could be at risk of contamination. Finally, the burnt fuel will be air-transported to Russia, where it will be turned into a safer form of low enriched uranium. This painstaking and costly process marked the first step in an aggressive new effort by the Obama administration to secure vulnerable nuclear material around the world. The new ability to ship all the material by air, however, could speed up the process considerably by reducing the number of countries that would have to grant permission for a shipment to cross borders. With the Romanian shipments, a total of 1,896 pounds of Russian-origin enriched uranium will be returned to Russia, from 11 countries.

But many arms control and counter-terrorism specialists have warned for years that the gravity of the terrorist threat has not been matched by the necessary urgency to secure the most vulnerable bomb materials [3]. Indeed, the job of securing the stockpiles is only about half complete. From Libya to Chile to Belarus, more than a dozen countries still maintain supplies of highly enriched uranium, both in the fresh and spent fuel form. Meeting Obama's aggressive schedule will be challenging, officials acknowledge. The Romania 'cleanout,' for example, cost \$10.5 million and was five years in the making, requiring a series of sensitive agreements with the host nation, Russia, and several international bodies. President Obama has said that preventing terrorists from acquiring a nuclear weapon is his top national security priority. In July, Obama will sign a joint declaration with Russian President Dmitry Medvedev in Moscow setting forth a framework to complete the removal of highly enriched uranium from 15 other countries within four years. That goal has taken on new urgency recently with intelligence assessments concluding that Al Qaeda and other terrorist groups have made obtaining nuclear material a central goal. 'Unless the world acts decisively and with great urgency, it is more likely than not that a weapon of mass destruction will be used in a terrorist attack somewhere in the world by the end of 2013,' the US Commission on the Prevention of Weapons of Mass Destruction Proliferation and Terrorism said in a report. But watchdog groups say there are still large amounts of uranium suitable for bomb making at research reactors in numerous countries. While the pace of removing highly enriched uranium from research reactors has stepped up, there still exists 'weak security at many of the roughly 130 research reactors worldwide still using such fuel,' said a 2008 report by Harvard's Belfer Center for Science and International Affairs. By removing all of its highly enriched uranium, the Romania operation is seen as a model for other countries that worry about the risks in giving up their nuclear materials. To the Romanian officials involved, the removal will improve both their country's security, and that of the world.

2. The Case of ‘Historical’ Radioactive Sources

For Romania, another important aspect is the potential danger of the so-called ‘historical’ radioactive sources (remnants from old research facilities, medical and industrial radioactive sources manufactured in NIPNE-HH and recuperated from the users, etc.) located in special deposits – e.g. Magurele ancient military fort, one million Ci, in the absence yet of a realistic inventory. Reprocessing and transfer to a more secure place (an old deep salt mine) has been started, but it is expensive and time consuming.

Relevant nuclear ‘incidents’ related to nuclear materials control in Romania from the last 40 years are:

- ‘crazy’ scientist cases: in 1974, a chemist contaminated a large area – several hectares near Bucharest (Scrovistea) – of forest (soil and trees) with radioactive liquids for an unauthorized ‘experiment’; hundreds of tons of radioactive waste processed in our Institute’s specialized department; in 1975 another similar incident – 57 deaths during the detection and recuperation of the radioactive sources used by another ‘crazy’ scientist for an experiment not clarified even today (improvement of crops quantities and quality?); in 1999, the family of the last ‘crazy’ scientist asked for a radioactive control in his home ‘laboratory’ after his death – a lot of weak radioactive sources were recuperated.
- personal ‘in family’ revenge using radioactive sources: in 1984 a nuclear technician tried to punish the family of his ex-wife poisoning them with I-131; in 1985 another nuclear technician tried to kill his unfaithful wife by poisoning her with Uranium salts from a Uranium minerals treatment plant; in 1982 the attempted romantic suicide of a rejected lover with a radioactive sealed gamma-graphy source.
- personal ‘job-related’ revenge using radioactive sources: in 1976 at a higher education institution some radioactive sources were stolen and abandoned by a former employee to compromise the leading team of the institution; in 1984 a guard from a nuclear objective stole a Co-60 source to blackmail his superiors – fortunately, he accepted a deal – ‘source in exchange for no punishment’.
- thefts of radioactive sources to recuperate the metal from their containers: in 1977 neutron sources for geological investigations stolen by gypsies.
- revenge in the case of administrative sanctions: in 1977 in a hospital some Co-60 sources were stolen and hidden to demonstrate the ‘incompetence’ of the hospital board (‘frustration’ psychology).
- ‘self-treatment’ amateurs: in 1959, a nuclear technician contaminated himself with Cobalt-60 chloride to improve his health condition; he also contaminated his family, but more easily.

- illegal import of radioactive sources for medical purposes (private medical care centers) to avoid bureaucracy and controls; absence of real inventory and possibility of trafficking (e.g. 1961: radioactive phosphorous for a 'home' anti-cancer treatment).
- intentional contamination of buildings hosting small nuclear units in the cities to facilitate their demolition and the construction of new expensive business buildings (several cases after 1990).
- massive export to India and other third-world countries (after 1990) of dismantled industrial equipment containing old – unknown – radioactive sources (e.g. metallurgical plants components with Co-60 sources or old medical equipment also containing Co-60 sources).
- abandoned low radioactive remnants from closed (after 1990) agricultural fertilizer plants – e.g. phosphogypsum.
- low radioactive sterile remnants around and in abandoned Uranium mines – relics of 1960 cold war period.
- 1977: strong earthquake in Romania. One consequence in our institute was contamination with liquid and solid radioactive materials from broken containers. Conclusion: the necessity of radioactive and physical protection against earthquakes.
- Mechanical accidents involving intense industrial radioactive sources (Co-60, Ir-192); strong irradiation of personnel.

Practical conclusions from these events are:

- the necessity for annual psychological checks on the staff authorized to handle radioactive materials is obvious, especially to avoid the development of a Frustration Psychology (family and job-related problems).
- the potential 'insiders' (professional staff working with radioactive substances) case must be strongly considered in terrorist risk evaluation.
- the necessity of a complete inventory of the radioactive materials in all the nuclear objectives (institutes, universities, hospitals, industrial units, etc.) and of its annual verification is requested. The problem of beta- and alpha-radioactivity (fire detectors) detection: no possibilities for recipients or packages.

3. Safety in the Transport of Radioactive Material

Safety in the transport of radioactive material is ensured by enclosing the material, when necessary, in packaging which prevents its dispersal and which absorbs to an adequate extent any radiation emitted by the material. Transport workers, the general public and the environment are thus protected against the harmful effects of the radioactive material.

The packaging also serves the purpose of protecting its contents against the effects of rough handling and mishaps under normal transport conditions, and against the severe stresses and high temperatures that could be encountered in accidents accompanied by fires. If the radioactive material is also fissile, special design features are incorporated to prevent any possibility of criticality under normal transport conditions and in accidents.

The safe transport requirements are designed to afford protection against unintentional opening of packages in normal handling and transport conditions and against damage in severe accident conditions; whereas the physical protection requirements are designed to prevent intentional opening of packages and deliberate damage.

- About twenty million packages of all sizes containing radioactive materials are routinely transported worldwide annually on public roads, railways and ships.
- These use robust and secure containers. At sea, they are generally carried in purpose-built ships.
- Since 1971 there have been more than 20,000 shipments of used fuel and high-level wastes (over 80,000 tons) over many million kilometres.
- There has never been any accident in which a container with highly radioactive material has been breached, or has leaked.

Problems for such a transport:

- the use of special locks and seals to prevent unauthorized opening of the packages;
- advance notification of the consignee to ensure that he is ready to accept delivery;
- special routing of the vehicle to avoid areas where disturbances or interception might be foreseen;
- planning of the transport to ensure the minimum travel time and the minimum number of transfers;
- adoption of full-load conditions, that is, sole use of a vehicle or aircraft by the consignor, all initial, intermediate and final loading and unloading being done in accordance with the directions of the consignor or consignee;
- the preferential use of aircraft, including helicopters;
- arrangements to ensure that a vehicle is never left unattended during transport;
- provision of a rapid communication system between consignor and consignee to indicate the precise time of arrival;
- continuous communication with the transport vehicle, and reports from checkpoints;
- use of escorts or guards in the same vehicle as the consignment and possibly in accompanying vehicles;
- use of special tie-down systems to prevent unauthorized removal of a package from the vehicle;
- use of vehicle disabling systems to prevent unauthorized diversion of the vehicle from the planned route;

- use of alarm systems to draw attention to and locate a vehicle under threat;
- provision for the rapid notification and dispatch of trained and equipped teams to recover any consignment under threat.

For international transport, special arrangements would have to be made in advance between the States concerned for ensuring continuity of such of these protective measures both within each State and at the frontier crossing points as are relevant to the particular shipment. Transport by air has obvious advantages from the point of view of reducing the travel time, of identification and monitoring of the location of the consignment, and of facilitating continuous protective supervision.

For Romania, we can mention the problem of international transport of nuclear fuel – e.g. on the Danube from and to Kozloduy Nuclear Power Plant. 60–90t radioactive materials transported 2–3 times per year from Kozloduy to Ismail (Ukraine) by Vasil Drumev, Nautilus and Fili ships, escorted by Romanian Gendarmerie Nuclear Unit on Romanian Danube line. Each time, the risk of naval incidents (large volume of traffic on Danube) must be evaluated.

Relevant events related to radioactive materials illicit trafficking in the last 15 years on Romanian territory are:

- 1992: 6,660 kg natural uranium pellets stolen by an employee from a chemical processing plant for sale in Western Europe – intercepted by Romanian Police.
- 1993: 5,170 kg U-235 enriched cylinder (former USSR provenance) intercepted by Romanian Police at Iasi – the border with Republic of Moldavia.
- 1996: Cs-137 sources recovered by Bucharest Customs service (contraband from ex-USSR?).
- 1991–1998: approx. 700 kg of various Uranium compounds were confiscated from unauthorized persons by Romanian authorities inside the country.
- 2001: heavy water from Turnu Severin plant intercepted by Romanian Customs service at Arad (border with Hungary).

Cross-border problem of radioactive wastes:

- 1981: Co-60 dismantled radioactive sources from Italsider metallurgical plants transported from Taranto to Bucharest-Magurele.
- 1991: Casagrande company (Italy) proposed to Romanian authorities to deposit in Magurele some low and medium radioactive wastes, paying for that – proposal rejected.

4. Conclusions

Within the past 5–7 years there have been very significant developments in the approach to nuclear security. The materials and facilities that are subject to security considerations are much broader than initially thought. We have new

international documents such as the Physical Protection of Nuclear Material Convention and the UN Security Council Resolution 1540, which contains obligations for all countries of the UN System to protect nuclear material from theft and put in place effective border controls, so that any undeclared, unauthorized or illegal movement of radioactive and nuclear materials could be caught at the borders or other locations. To manage such situations in Romania, in 2000, a special Nuclear Police unit having dosimetric-detection systems, handling and decontamination equipment and dedicated transport facilities, was created. Also, the Customs services now have special equipment for the detection of radioactivity (especially gamma and beta). For many dangerous nuclear materials the alpha radioactivity is relevant, but, unfortunately, active detection procedures for this type of radioactivity are not yet possible during a Customs inspection.

In the case of new potential nuclear incidents, from our post-Chernobyl experience [4, 5], as conclusions on how to organize a radioactive contamination measurements activity, we can mention:

- free access to many portable and robust radiometers;
- standardized measurement procedures for environmental and foodstuffs samples (specimens preparation, geometry);
- available standard radioactive solutions, point and volume sources;
- portable large volume NaI(Tl) counter, coupled to Single Channel Analyzers for I-131 determination in thyroid.

We must add the necessity of prompt, correct and sincere information by the governmental authorities, essential to establish a solid, confident relationship with the population and to minimize psychological effects.

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INTEGRATED RISK AREA PLANNING: THE CASE OF MILAN METROPOLITAN AREA

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Abstract As a follow up of the first Regional Plan for Integrated Risk Assessment and Management (PRIM 2007–2010), Regione Lombardia has scheduled the development and release of the first four Integrated Risk Area Plans (2008–2010). They regard areas chosen to represent significant case studies where several different risks interfere mutually, and therefore they are relevant experimental fields where the integrated risk methodology especially developed for the PRIM 2007–2010 can be further developed on and adapted to a sub-regional scale. The above-mentioned methodologies and issues are carefully developed and tested for their extensive use not only in Lombardia but also in the other Italian provinces and regions. This is the reason why the first four plans have been completely funded by the Italian Ministry of the Environment. Currently Regione Lombardia is in the way of finalizing the first plan regarding Milan Metropolitan Area. This paper presents general information on the four Integrated Risk Area Plans and specific details on that relating to the Milan Metropolitan Area.

1. Introduction

As a follow up of the first Regional Plan for Integrated Risk Assessment and Management (PRIM 2007–2010), Regione Lombardia has scheduled the development and release of the first four Integrated Risk Area Plans (PIAs, *Piani per il Rischio Integrato d'Area*).

They regard the following integrated risk areas (see [Figure 1](#)):

- Milan Metropolitan Area;
- Brescia Area;
- Lecco Area;
- Sempione Area (between Milan and Varese).

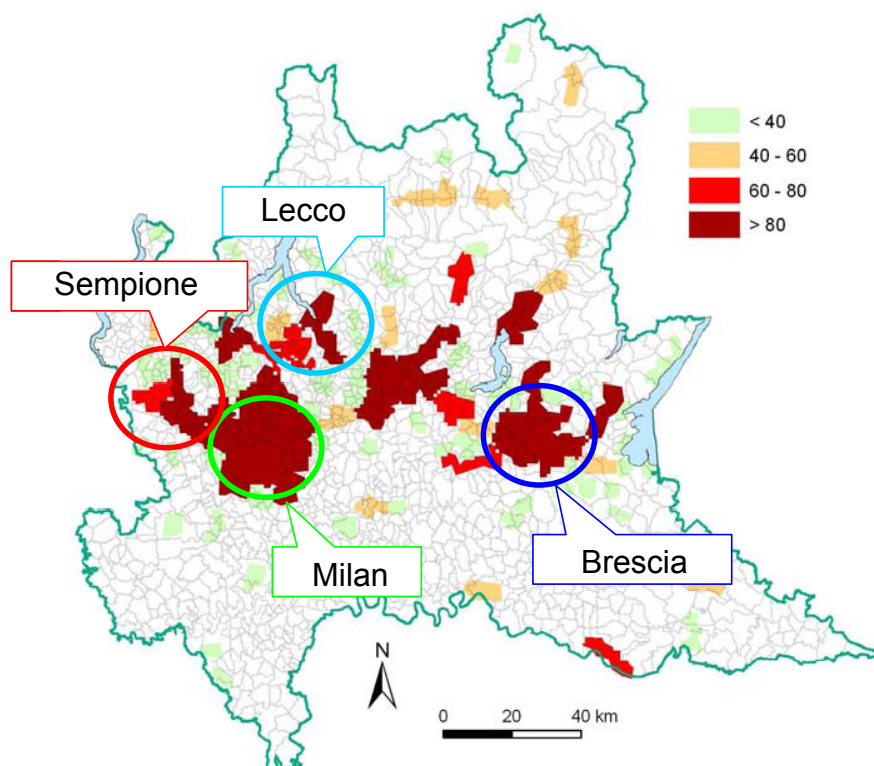


Figure 1. Areas selected for the development of the first four Integrated Risk Area Plans as a result of PRIM 2007-2010.

These areas have been chosen because they represent significant case studies where several different risks interfere mutually, and therefore they are relevant experimental fields where the integrated risk methodology especially developed for the PRIM 2007–2010 can be further developed and adapted to a sub-regional scale.

As a matter of fact the first four PIAs concern areas characterized by contiguous elementary square cells (1 km^2) with at least two hazards with a minimum risk level triple the regional average and a total surface area greater than 80 ha, as shown in Figure 1.

Milan Metropolitan and Sempione Areas represent territories where industrial risks, transport of dangerous goods and typical social risks (road and work accidents) are mutually involved. Brescia and Lecco Areas introduce significant natural risks (mainly hydro-geological but also seismic for Brescia Area) in an otherwise industrialized context.

The project will cover a three-year period (2008–2010). Currently Regione Lombardia is in the way of finalising the Milan PIA, is processing the Brescia PIA and is launching the Lecco and Sempione PIAs.

2. Aims and Operating Strategies of the PIAs

2.1. AIMS

As previously explained, the main aim of PIAs is to focus on specific areas of Regione Lombardia where the regional scale risk assessment carried out for PRIM 2007–2010 has shown that more individual risks coexist and can interact.

Focusing on ‘smaller’ areas gives the chance to move from an ‘overview/regional approach’ (PRIM 2007–2010, regional plan) to a more ‘locally-based approach’ (PIAs, area plans) with the ultimate goal of giving sufficient operative tools to Provinces and Municipalities (legally bound to plan the local territorial and urban development) for a satisfactory fulfilment of their own local mission.

2.2. OPERATING STRATEGIES

Four operating strategies have been recognized for each single PIA:

1. The first operating strategy is to reduce the minimal grid dimension used in the risk assessment process in order to increase its resolution and thus reliability.
2. The second operating strategy is to develop a risk assessment methodology not more parametric and quali-quantitative (PRIM 2007–2010) but definitely rational and quantitative (PIAs).
3. The third operating strategy is to carry out risk assessment at two different levels:
 - a. a first-level approach for the whole area;
 - b. a second-level (or detailed) approach for the hot-spots recognised on the basis of first-level results.
4. The fourth operating strategy is to guarantee robust and reliable evaluation methods for risk mitigation at provincial and municipal level.

3. Milan Metropolitan Area Integrated Risk Area Plan

3.1. TERRITORY COVERED

The territory covered by the Milan PIA (see [Figure 2](#)) regards:

- 2 provinces (part of Milan province and the whole new Monza e Brianza province);

- 136 municipalities;
- 1,417 km²;
- more than 3,000,000 inhabitants.

It is a typical densely populated area that comprises 9 municipalities above 40,000 inhabitants (Milan – about 1,300,000 inhab., Monza – about 120,000 inhab., Sesto San Giovanni – about 80,000 inhab., Cinisello Balsamo, Legnano, Rho, Cologno Monzese, Paderno Dugnano and Seregno) and several important motorways, national/provincial roads and railways.

3.2. METHODOLOGY ADOPTED

With regard to the above-mentioned four operating strategies that each PIA must develop, the Milan PIA:

1. has reduced the PRIM grid dimension from 1,000×1,000 m² to 500×500 m²: that gives the chance to obtain all data needed at the appropriate scale; grid dimension has been further reduced to 50×50 m² in the hot-spot areas where the ‘second-level’ risk assessment has been carried out (see point 3);
2. has proposed a social quantitative risk assessment method (expressed in terms of human fatalities) based on a limited but accurate set of territorial data (resilience included) for all eight hazards considered (industrial, transport of dangerous goods, hydro-geological, meteorological, seismic, forest fires, road accidents, work accidents) and all their possible domino effects (nat–nat, nat–tech, tech–tech); the proposed methodology is in this way to be extended from human risk only to all environmental/territorial casualties: this means that not only human fatalities but also economic damage to the environment and critical or cultural infrastructures will be assessed as well as possible;
3. has developed a two-level risk assessment: a ‘first-level’ approach for the whole area and a more detailed ‘second-level’ approach for the two recognized hot-spots (one of them is the area where the 2015 Expo will be held);
4. has defined a practical and diversified set of risk mitigation actions that strictly depends on the ‘first-level’ and ‘second-level’ risk assessment results.

4. Data Mining

Significant amounts of data have been collected with the aim of representing as much as possible:

- all major hazards;
- the territorial vulnerability;
- the territorial resilience/coping capacity.

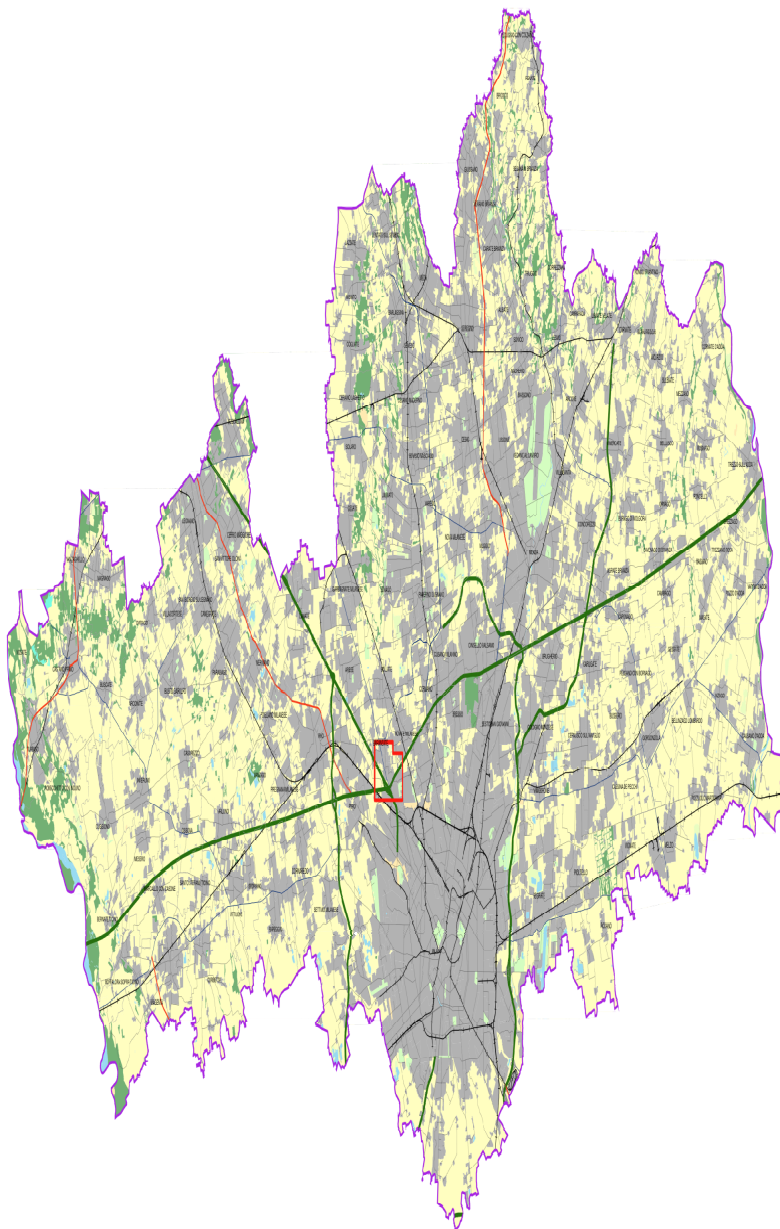


Figure 2. Territory covered by the Milan PIA. The red pseudo-rectangle represents the recognised hot-spot. Transport networks: green (motorways); red (national roads); blue (provincial roads); grey (municipal roads); black (railways).

All data collected have been geo-referenced in a specifically built GIS (Geographic Information System) using two different square grids (and, therefore, details):

- 500×500 m² for the ‘first-level’ risk assessment;
- 50×50 m² for the ‘second-level’ risk assessment.

4.1. HAZARDS

Major hazards considered have been:

- industrial activities (both Seveso and non-Seveso activities) [technological];
- transport of dangerous goods (via road and railway) [technological];
- hydro-geological (mainly floods, due to the generally flat configuration of the territory: 100–300 m above sea level) [natural];
- meteorological (lightning) [natural];
- seismic (seismic acceleration) [natural];
- forest fires [natural];
- road accidents (historical data) [social];
- work accidents (historical data) [social].

4.2. VULNERABILITY

Territorial vulnerability has been characterized on the basis of the following objects and soil uses:

- residential population distribution;
- sensitive infrastructures densely ‘populated’ such as hospitals, schools, airports, train/subway stations, bus stops (hot-spots only), cinemas, fairs, hotels, campsites/tourism resorts, industrial settlements, commercial centres, sport centres, transport networks (motorways, other roads and railways) and fuel stations;
- other sensitive ‘non-populated’ infrastructures such as electric lines and water channels;
- protected areas, waterways and lakes, forests, public and private parks and other agricultural and non-agricultural soil uses.

Since the Milan PIA is focused on social risk (i.e. human fatalities) most of this information has been used with the main goal of calculating the so-called ‘population equivalent’ (see [Figure 3](#)) that is, the population that could be present in an elementary square cell (0.25 km²) as ‘true’ inhabitants, workers, students,

‘site-users’, passers-by, etc. Each inhabitant, ‘true’ or ‘temporary’, has been weighed by means of a suitable coefficient that takes into account the frequency of his presence inside each specific cell.

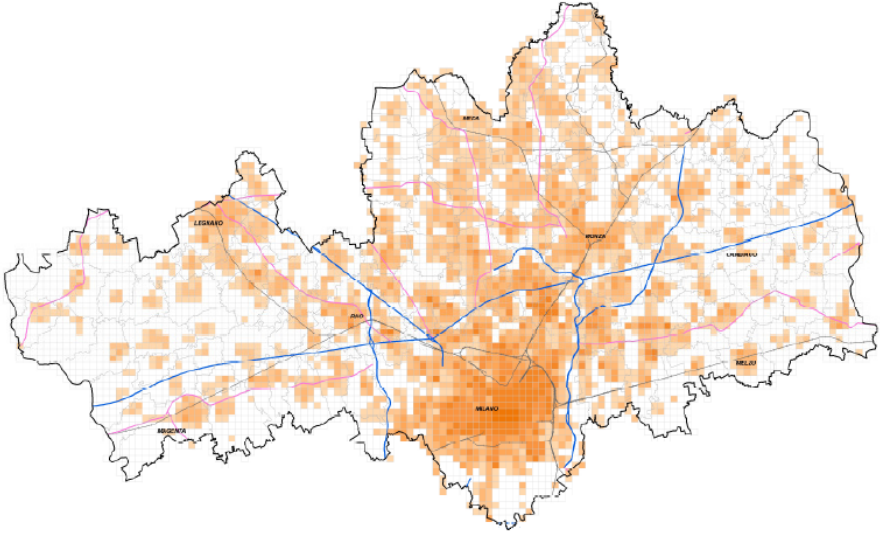


Figure 3. ‘Population equivalent’ calculated for each 500m square cell.

4.3. RESILIENCE/COPING CAPACITY

Territorial resilience/coping capacity has been characterized on the basis of the presence of or distance from the following resources:

- Civil Protection groups (voluntary, municipal, inter-municipal);
- municipal Civil Protection Plans;
- emergency call-centres;
- fire brigades;
- police departments;
- hospitals.

A specific resilience factor has been calculated for each cell and for each hazard (this takes into account the obvious fact that the coping capacity is hazard-specific and cannot be assimilated for hazards of different natures).

5. Risk Assessment Method

A social quantitative risk assessment method has been specifically developed and is formulated as follows:

$$IR_j = \sum_i (r_{ij} \times g_{ij} \times c_{ij} \times f_{ij}) \times PE_j$$

where:

IR_j = integrated risk for the j -th cell [fatalities year⁻¹]

r_{ij} = resilience factor for the i -th hazard and the j -th cell [–]

g_{ij} = gravity factor for the i -th hazard and the j -th cell [fatalities affected⁻¹]

c_{ij} = conversion factor for the i -th hazard and the j -th cell [affected present⁻¹]

f_{ij} = frequency of the i -th hazard and for the j -th cell [occurrence year⁻¹]

PE_j = time-average population equivalent of the j -th cell [present occurrence⁻¹]

The integrated risk is expressed in terms of human fatalities per year in each cell weighed through the gravity factor for each hazard assumed equal to:

- 1.00 for death;
- 0.25 for irreversible injuries;
- 0.01 for reversible injuries.

The conversion factor considers the practical observation that, for some kind of hazards, affected people are only a more or less significant fraction of people that could be theoretically affected (of course, the conversion factor is unitary for the hazards measured on a historical basis, as road and work accidents).

The resilience factor is a correction factor in the range 0.9 (high resilience) to 1.2 (low resilience) calculated for each hazard as explained in Section 3.3.3.

The hazards considered are not only the eight ‘basic’ hazards but all their possible domino effects (nat–nat, nat–tech, tech–tech). Chain (domino) effects considered are summarized in [Table 1](#).

6. Risk Assessment Results

Values of integrated risk for each 0.25 km² square cell after ‘first-level’ analysis and for each 0.25 ha square cell after ‘second-level’ analysis are shown in maps reproduced respectively in [Figure 4](#) and [Figure 5](#).

6.1. ‘FIRST-LEVEL’ RISK ASSESSMENT

‘First-level’ risk assessment has shown that:

- road accidents are the major risk in Milan Metropolitan Area (up to 10 fatalities year⁻¹ in cells crossed by the motorway approaching Milan);

- industrial risk is generally particularly high (up to 2 fatalities year⁻¹) in cells where Seveso activities are located in densely populated areas, but also in Milan (up to 10⁻¹ fatalities year⁻¹) where many small non-Seveso activities are located in a very densely populated area;
- work accidents are widely distributed with a medium-high value (order of magnitude 10⁻¹ fatalities year⁻¹);
- transport of dangerous goods via road poses major risks (up to 10⁻² fatalities year⁻¹) and in the same cells where road accidents are high; transport of dangerous goods via railway poses risks generally one order lower than transport of dangerous goods via road (up to 10⁻³ fatalities year⁻¹);
- natural risks are generally negligible, with major effects of seismic activities in Milan due to the very high ‘population equivalent’ density, and in the Eastern part of the area due to higher seismic acceleration (up to 10⁻² fatalities year⁻¹).

TABLE 1. Possible chain (domino) effects between single hazards considered in the risk assessment.

		EFFECT							
		industrial activities	transport dangerous goods	Hydro- geological	Meteoro- logical	Seismic	forest fires	road accidents	work accidents
CAUSE	industrial activities	×	×				×	×	×
	transport dangerous goods	×	×				×	×	
	hydro- geological	×	×					×	
	Meteoro- logical (lightning)	×	×				×	×	
	Seismic	×	×					×	
	forest fires	×	×				×	×	
	road accidents		×					×	
	work accidents	×							

Table 2 summarizes, for each hazard, the main domino effects (as per Table 1) and their integration, risk average values and relative (partial) surface areas where each hazard is measurable (mathematically speaking, risk higher than 0). The average values in Table 2 have been calculated taking into account only the relative (partial) surface areas defined above and not the whole PIA area.

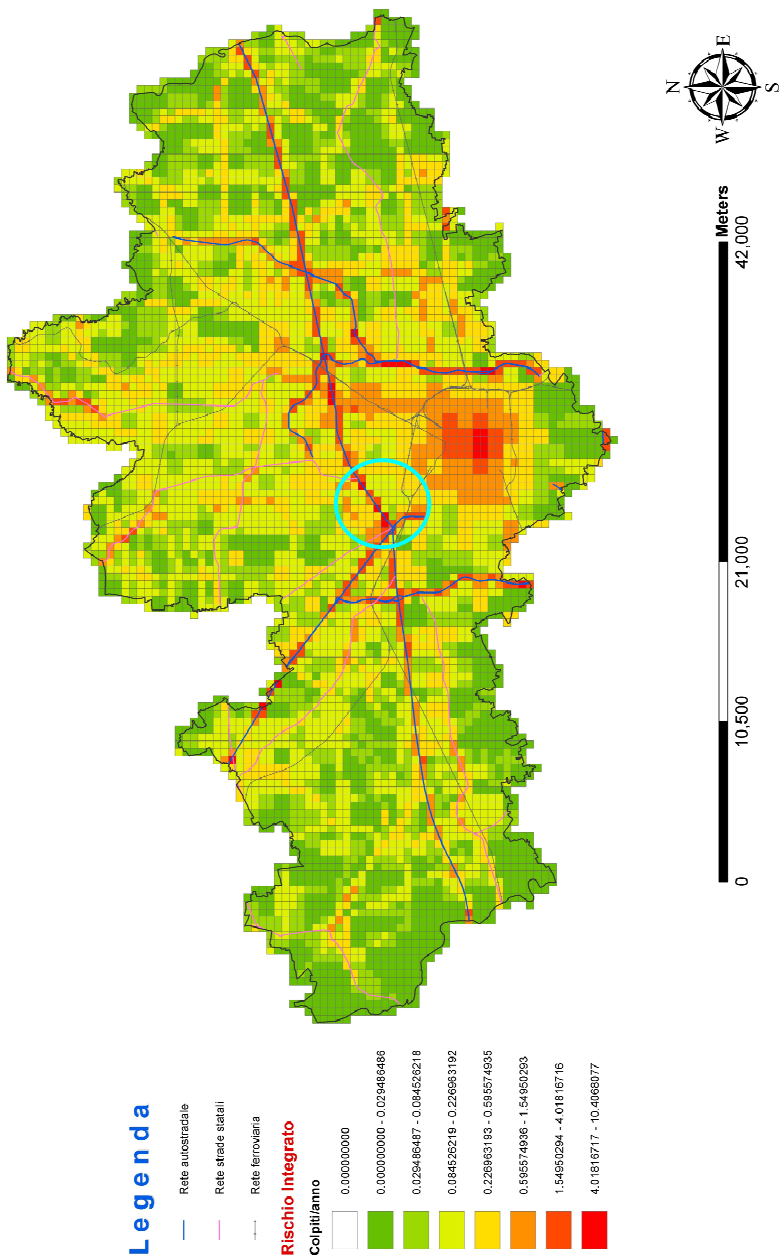


Figure 4. Integrated risk as a result of ‘first-level’ risk assessment on the whole area. The cyan circle shows the hot-spot identified after ‘first-level’ analysis.

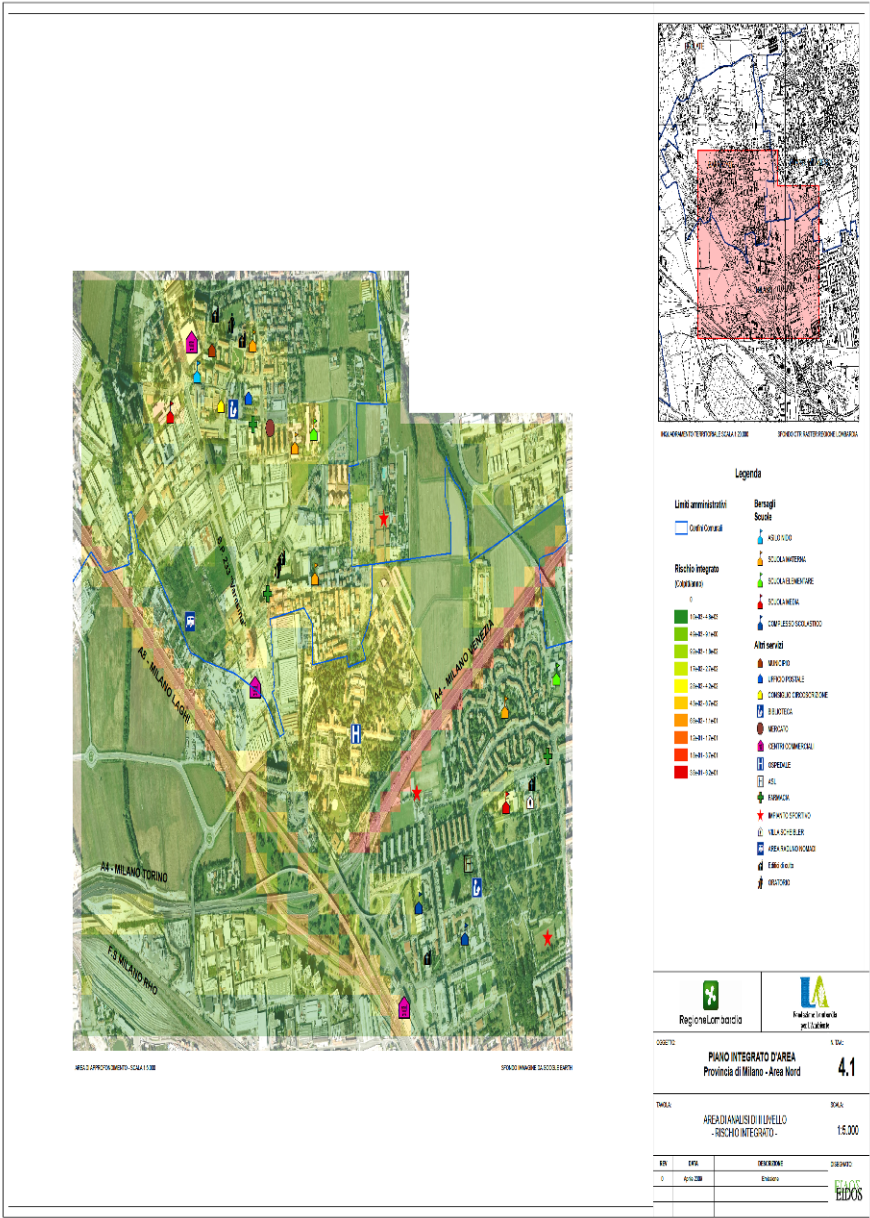


Figure 5. Integrated risk as a result of ‘second-level’ risk assessment on the hot-spot identified after ‘first-level’ analysis.

TABLE 2. Risk average values and relative (partial) surface areas considered for each hazard, the main domino effects and their integration.

Hazards/Domino effects	Surface area [km ²]	Risk (average value) [fatalities year ⁻¹ cell ⁻¹]
SINGLE HAZARDS		
Road accidents	533	3.42×10^{-1}
Work accidents	1,364	1.49×10^{-1}
Seveso industrial activities	34	6.43×10^{-2}
Non-Seveso industrial activities	850	3.50×10^{-3}
Seismic	1,417	1.58×10^{-3}
Transport dangerous goods	528	6.05×10^{-4}
Forest fires	721	4.48×10^{-4}
Hydro-geological	69	2.40×10^{-5}
Meteorological (lightning)	1,417	2.00×10^{-6}
MAIN DOMINO EFFECTS		
Non-Seveso to non-Seveso	74	6.31×10^{-3}
Seveso to Seveso	5	3.32×10^{-3}
Hydro-geological to Seveso	2	1.49×10^{-3}
Forest fires to Seveso	11	2.58×10^{-4}
Hydro-geological to non-Seveso	43	2.09×10^{-4}
Transport dangerous goods to Seveso	15	1.43×10^{-4}
Seveso to non-Seveso	21	1.36×10^{-4}
Transp. dangerous goods to forest fires	721	2.96×10^{-5}
Transp. dangerous goods to non-Seveso	278	7.00×10^{-6}
Forest fires to non-Seveso	71	5.00×10^{-6}
Non-Seveso to forest fires	46	7.00×10^{-7}
Seveso to forest fires	12	1.60×10^{-7}
INTEGRATED RISK		
Total (all hazards and domino effects)	1,417	2.77×10^{-1}

The choice of the hot-spots where the 'second-level' analysis has been carried out depended on the occurrence of all the following conditions:

- very high integrated risk;
- significance of road accidents and industrial risk.

This condition is satisfied in a cluster of cells at the boundaries of three municipalities: Baranzate, Milan and Novate Milanese. This area (about 4.0 km², corresponding to about 1,600 50×50 m² cells) is characterized by one Seveso

activity, the crossroad of two motorways and one important provincial road, one railway cargo terminal, one important hospital, several residential areas and schools.

Natural hazards have not been considered as a criterion for choice, since their local risk values are several orders of magnitude lower than social/technological hazards.

TABLE 3. Risk average values: comparison of the results of the ‘first-level’ and ‘second-level’ analyses. Differently from Table 2 and for comparison purposes, average values have been spread over the whole available territory (PIA for ‘first-level’ and hot-spot for ‘second-level’).

Hazards	Risk (average value) [fatalities year ⁻¹ km ⁻²]	
	“First-level” analysis: whole PIA territory [1,417 km ²]	“Second-level” analysis: hot-spot[about 4 km ²]
Work accidents	5.74×10^{-1}	8.03×10^{-1}
Road accidents	5.15×10^{-1}	$4.40 \times 10^{+0}$
Non-Seveso industrial activities	8.40×10^{-3}	2.42×10^{-2}
Seismic	6.32×10^{-3}	6.64×10^{-4}
Seveso industrial activities	6.17×10^{-3}	$1.62 \times 10^{+0}$
Forest fires	9.12×10^{-4}	4.23×10^{-9}
Transport of dangerous goods	9.02×10^{-4}	1.18×10^{-2}
Meteorological (lightning)	8.00×10^{-6}	1.16×10^{-6}
Integrated risk	$1.11 \times 10^{+0}$	$6.87 \times 10^{+0}$

A second hot-spot has been recognized close to the Western boundary of the first one in correspondence of the area where the 2015 Expo will be held (Rho-Pero, new Milan international trade fair quarter). ‘Second-level’ analysis in this second hot-spot is currently still to be finalized.

6.2. ‘SECOND-LEVEL’ RISK ASSESSMENT

‘Second-level’ risk assessment has confirmed the results of the ‘first-level’ risk assessment, emphasizing the vulnerability of the main sensitive objects. Hazards, vulnerability and resilience have been recalculated taking into account the deeper knowledge of the territory and the finer square grid. Domino effects are shown to be not particularly important.

In Table 3 a comparison of the results of the ‘first-level’ and ‘second-level’ analyses is shown. Due to the different grid dimensions of the two analyses, risk has been averaged over 1 km² fictitious cells. The comparison confirms the hot-spot as an area characterized by high risk of road accidents, industrial activities

and transport of dangerous goods (one to two orders of magnitude higher than the whole Milan PIA territory) with an integrated risk 6 times the PIA average value.

7. Risk Mitigation Measures Proposed

In accordance with the different level of detail of the risk assessment ('first-level' and 'second-level'), risk mitigation measures proposed also have a different level of accuracy.

TABLE 4. Typical 'first-level' risk mitigation measures proposed.

Hazards	Short-term measures	Medium/long-term measures
Industrial activities	Safety report update/quick validation Emergency plan update Emergency signals	Process/plant upgrade City planning upgrade Emergency plan test Safety management system certification Voluntary fire brigades/civil protection
Transport of dangerous goods	Codes/regulations compliance enforcement Emergency plan update	Route improvement Emergency plan test Voluntary fire brigades/civil protection
Hydro-geological	Emergency plan update Emergency signals	Infrastructural measures Emergency plan test
Meteorological (lightning)	Best practices Information/education	Infrastructural measures
Seismic	Emergency plan update Information/education	Infrastructural measures Emergency plan test
Forest fires	Emergency plan update Good housekeeping	City planning upgrade Emergency plan test Alerting measures
Road accidents	Codes/regulations compliance enforcement	Infrastructure upgrade
Work accidents	Safety report update/quick validation Inspections/controls enforcement	Safety management system certification Internal first-aid centre

7.1 'FIRST-LEVEL' RISK MITIGATION

'First-level' risk mitigation measures reflect the 'macro-scale' level of the risk assessment carried out. The short-term and medium/long-term measures proposed

are, as a consequence, not site-specific but could help to drive Provinces and Municipalities (directly responsible for risk mitigation at local level) towards the best site-specific measures.

In [Table 4](#) a scheme of possible risk mitigation measures for single hazards is summarized. A scheme of possible risk mitigation measures is available also for domino effects but is omitted here, since it is in many cases an adaptation of [Table 4](#) that takes into account typical cascade effects.

Local authorities will be provided with a specific package containing:

- maps of integrated (total) risk and dominant (main) risk obtained as a result of the ‘first-level’ risk assessment (0.25 km² square grid);
- a detailed list of short-term and medium/long-term measures proposed (as shown as an example in [Table 4](#)).

Since Milan PIA covers a 1,417 km² territory with 136 municipalities, 9 different specific packages have been prepared reflecting the division of the whole territory into 9 homogeneous sub-areas. Each sub-area groups 15–20 municipalities, and related maps also cover neighbouring municipalities. This approach has the double aim of:

- package reduction without any loss of relevant information;
- relevant information is considered; not only that directly relating to each single municipality, but also that relating to a reasonably enlarged area where hazards could occur or could produce their undesired effects: it is largely known that most critical situations arise near the administrative borders where a lack of knowledge about what happens beyond the border could mask relevant hazard causes/effects (one clear example of this topic is the hot-spot of Milan PIA where a hospital and several schools have been built at the border of one municipality, neglecting or disregarding the fact that a hazardous industrial activity is located a few hundred metres beyond the border).

7.2. ‘SECOND-LEVEL’ RISK MITIGATION

Unlike ‘first-level’ risk mitigation measures that are necessarily not site-specific, ‘second-level’ risk mitigation measures reflect the very detailed level of the risk assessment carried out. Short-term and medium/long-term measures proposed are, as a consequence, site-specific at all. Nevertheless their implementation/enforcement remains a typical responsibility of Provinces and Municipalities.

Short-term risk mitigation measures identified are:

- emergency plans update (both Seveso activity and hospital);
- emergency signals audible also from hospital bus-stop and connected to road and railway traffic lights in order to block all access to the hazardous area in case of need.

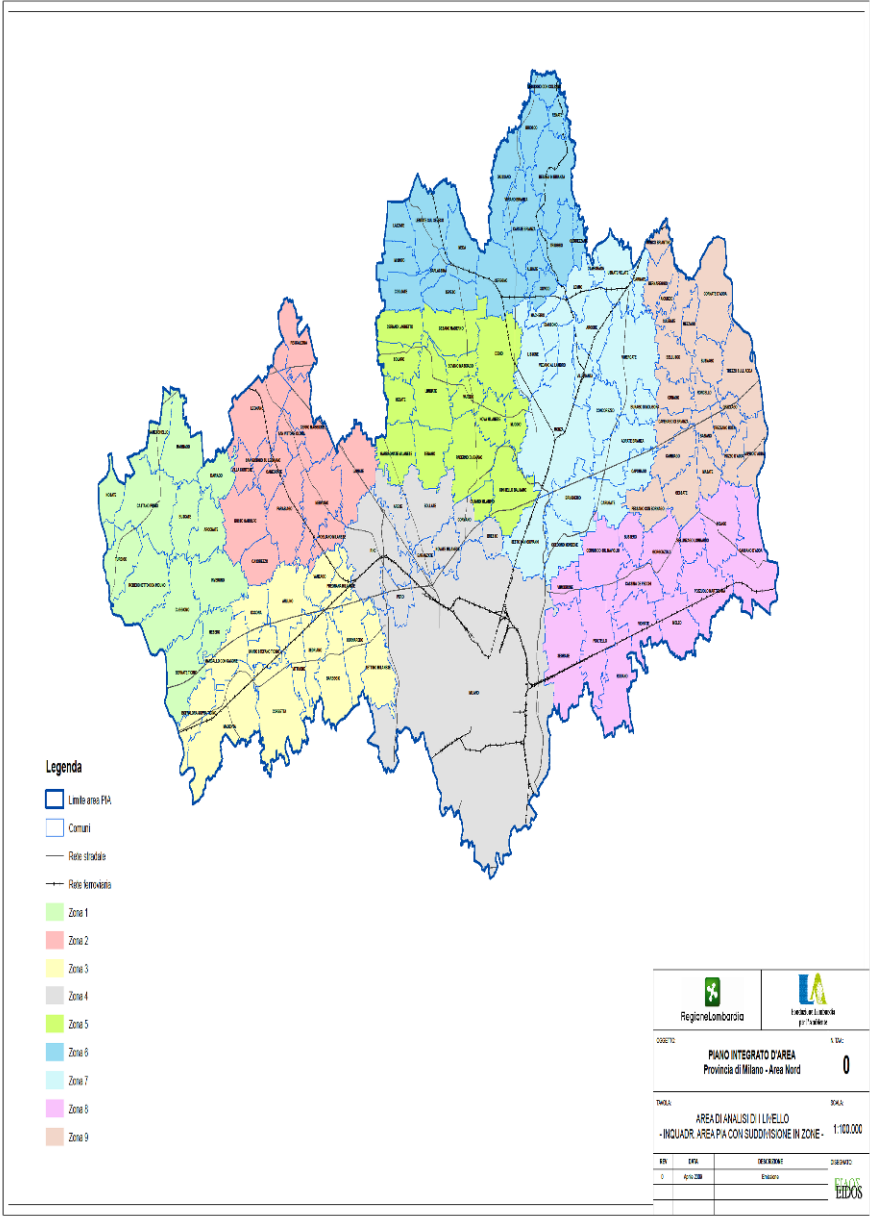


Figure 6. Sub-areas introduced in order to summarize main results of the Milan PIA to the local authorities.

Medium/long-term risk mitigation measures identified are:

- process/plant upgrade of the Seveso activity in order to reduce frequency and affected area of possible accidents;
- new inter-municipal city planning in order to avoid the licensing of new incompatible infrastructures;
- emergency signals connected to special motorway traffic lights and devices in order to block all access to the hazardous area in case of need.

8. Conclusions

The Milan PIA is the first of four Integrated Risk Area Plans where specific methodologies will be carefully developed and tested for their extensive use not only in Lombardia but also in the other Italian provinces and regions.

This is the reason why the first four PIAs have been completely funded by the Italian Ministry of the Environment (MATTM, *Ministero dell'Ambiente e della Tutela del Territorio e del Mare*) and MATTM and Regione Lombardia have agreed to create an evaluation body for the control of the entire research development, also with practical and technical suggestions.

The final products (the first four PIAs) will be adequately introduced and critically explained not only to their respective public and private local stakeholders (already involved during the development process) but also to the other Italian regions according to a suitable 'methodology transfer' scheme.

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9. Abbreviations

GIS	Geographic Information System
MATTM	<i>Ministero dell'Ambiente e della Tutela del Territorio e del Mare</i> (Italian Ministry of the Environment)

- PIA *Piano per il Rischio Integrato d'Area* (Integrated Risk Area Plan)
- PRIM 2007–2010 First Regional Plan for Integrated Risk Assessment and Management.

CONCLUSIONS

The papers in this publication have shown, in their respective expertises and areas of interest, that the current international situation is characterized by a number of destabilizing factors to be essentially summed up by: unpredictability, rapidity and global spread.

The results of such features are new threats (such as piracy, economic crisis, nuclear proliferation, food crises) that undermine global stability and therefore require collective and co-ordinated responses, leading, indeed, to a new concept of 'security'.

This new concept should not be limited to a territorial perspective: nowadays security has a wider reach, a more dynamic and constantly changing vision of security that is not only related to national borders.

Citizens' security and safety and, from a wider point of view, human security are the fundamental core objectives that all of us should be looking at, in order to achieve the necessary cohesion to act promptly in the event of major international crises.

To reach the goal, refined methods, towards which the international community is making efforts, can be various, but they cannot be separated from:

- activating and developing partnerships in policy making, knowledge transfer and implementation;
- comprehensive approach, to ensure the greatest possible coordination between all the countries, regional stakeholders and international institutions;
- multi-level vision and approach in order to achieve a better coordination crisis management.

All this should be set in the framework of the common values and internationally recognized principles of democracy, freedom and the rule of law to be woven into a continuous path.