Risk, Territory and Society:

Challenge for a Joint European Regulation

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A Bianca e Sofia,

cioè a tutti noi

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Abstract

In 2004, the Major Accidents Hazards Bureau of the Joint Research Centre of the European Commission launched the "Land Use Planning Including MAHB and NEDIES" research programme, in the context of which most of the research collected in this book was conducted. The focus of the investigation was on the different methods developed by Member States for implementing Art 12 of the Seveso II Directive, stating the *Control of Urbanization* requirement. Art 12 is the first European requirement calling Member States to "*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 policies".* Scope of the MAHB investigation was providing an up-to-date overview of national implementations of Art 12 in order to elaborate the relevant Guidance and providing Member States with additional supporting instruments. The Guidance was adopted by the European Commission in November 2006. Based on a questionnaire survey, literature review and direct interviews with the members of the European Working Group on Land Use Planning (EWGLUP), the investigation led to the elaboration of a second supporting instrument, the *Roadmaps*. In this research document, the different methods developed in a selected group of Member States (The Netherlands, the United Kingdom, Germany, France and Italy) for implementing Art 12 are investigated. Recommendations for best- practice in the field are given.

In the autumn of 2004 the PhD project was involved in the investigation and particularly in the elaboration of the *Roadmaps*. But whereas this research document ended with reporting the different approaches developed in the European Union, the PhD project tried to explain them. Which are the characterizing elements of the different national implementations of Art 12? What determined the development of different methods for land use planning in "Seveso" areas in the relevant national practices? Are different national approaches leading to different levels of prevention? How are political views and cultural orientations influencing their adoptions? Finally, which is the role and which are the perspectives of the European regulation in the light of these differences?

In order to reply to these questions, the book starts with providing a set of guiding definitions relevant to the matter of industrial risk in land use planning. These definitions are functional to support the reading of the book by the side of the reader less familiar with the terms in use in the field of risk prevention, being the target-audience of the investigation primarily represented by planners and policy-makers. Different definitions of risk and its counterparts are analyzed together with several relevant terms in use in literature. In so doing, different perspectives on the matter of technological risk prevention are introduced. The paradigm of "risk society" (Beck 1992) is discussed and some of its controversial interpretations are resolved by providing important distinctions among different types of risks, namely natural vs. technological and systemic vs. site-specific risks.

In the following, world famous major accidents and the relevant *lessons learned* are described. The limits of a mono-dimensional characterization of risk in land use planning are discussed and the adoption of a multi-dimensional characterization of the consequences of accidents is proposed. The book continues with providing a comprehensive analysis of the regulatory developments of the Seveso Directives from 1982 to 2006 and of the "lessons learned from accidents" reflected in their scope and requirements. These lessons are observed through the multi-dimensional lenses proposed in the previous Chapters: would have the calculation of the "essence of risk" equation captured the political, ethical and social consequences of accidents like the one occurred in Bhopal in 1984? This question opens to a sound ethical reflection. The ethical principles applicable to the governance of major accidents risk and the liability issue to them associated are therefore discussed. An ethical framework suitable to provide guidance to the further

European regulatory developments and conclusions over the desirability of a regulatory system based on *ex-ante* regulations and *ex-post* liability rules are derived.

The core of the book is the comparison among representative national transpositions of Art 12. Here, the variables (quantitative vs. qualitative) which may explain the different methods and policies are investigated. In particular, deterministic vs. probabilistic methods are compared by means of a case-study. Whereas the first approach revealed to be more sensitive to the hazardous substances inventory, and therefore an incentive to its reduction by decrease or dislocation, the second approach appeared to incentive the increase of the safety performance of establishments and the reduction of vulnerability of the surrounding areas. It can be therefore generally concluded that it is the underlying *scope* and not the *result* of land use planning evaluations that appears to determine the adoption of one of the two methods. Here, the demographic variable and different national legislative contexts may be a determinant factor. In this perspective, the choice between the two orientations confirms to be influenced by the political and territorial context of regulations rather than by mere methodological considerations.

A third and somehow complementary analysis focuses on the cultural variables which may have influenced the adoption of different approaches to the overall matter of land use planning in Seveso areas. Here, the cultural theories of Hofstede are used as a reference for addressing some interesting conclusions on the existence of a "cultural orientation" in risk prevention policies. The European national cultures classified as uncertainty-adverse by the Dutch sociologist correspond to the legislative contexts in which a semi-quantitative or deterministic approach are prescribed. Even here, risk regulation reveal to be an inherently "national political issue".

The conclusions of the book summarize the findings discussed in the course of its development. The ethical, legislative and cultural elements determining different "roadmaps" for land use planning in Seveso areas are discussed. The main research question replied in the conclusions regards the "limits and horizon" of a common European regulation in the light of these sometimes remarkable differences. In principle, whereas legitimate cultural and political orientations and specific territorial factors determine the adoption of different methods to approach the matter of industrial risk in land use planning, the European regulation holds the responsibility of providing Member States with a cross-national regulatory framework suitable to overcome the limits of national legislations and measures. Industrial major accidents are potentially trans-frontier phenomena; furthermore, the obligations deriving from the scope of Directives such as the Seveso are necessarily cross-cultural *moral* obligations. Can they and the instruments to comply with them be better reflected at European framework level?

Here, several indications are provided. The first is the proposal of adopting a multi-dimensional definition of the consequences of risk at European framework level. In the text of the Seveso Directive, risk is defined as "*the likelihood of a specific effect occurring within a specified period or in specified circumstances*". Being the general scope of the Directive limiting the consequences of major accidents to man and the environment, national legislations provide criteria for "measuring" them in terms of health effects and, in some cases, loss of environmental patrimony. In simple words, the consequences of the risk of concern are generally mono-dimensional: the deaths of humans is what need to be prevented. As argued in the course of the book, the consequences of the accidents that influenced the development of the European regulation would have not been "captured" by this characterization. Bhopal remains sadly famous in history for having led to question the ethical reliability and the very desirability of the chemical industry, and for having highlighted the limits of the legal instruments and resources at disposal for compensating the social, environmental and hence long-term damages provoked by the accident. *Sensitive* risk policies should therefore address the matter of risk in the multi-dimensional perspective of their overall *immediate* and *tangible* and *long-term* and *intangible* consequences in

order to incentive a more sound consideration of the measures to be put in place for their prevention.

These reflections opened to the ethical considerations addressed in the conclusions. The moral obligations of *informing*, *improving* and *compensating* are surely relevant to the scope of the Seveso Directives. However, whereas the first is explicitly mentioned in the relevant text and the second explicitly mentioned in the corpus of regulations complementary to the mandate of the Directives, the obligation to *compensate* found minor consideration. Here, the concept of *safety as spatial benefit* derived by Moroni (Chapter 2) may represent a "way forward". Site-specific residual risks lead to an unequal distribution of safety in society; leveling such inequality is only possible by means of the allocation of additional spatial benefits, which shouldn't be confused with the provision of the additional technical measures (ATM) prescribed by Art 12. Whereas some recent national legislations address this problem explicitly, a concrete indication at European level to enforce this obligation is missing.

A third consideration regards the methodological orientations of European countries. The much debated adoption of deterministic vs. probabilistic methods and the search of an equally applicable "model" to resolve the matter of industrial risk in land use planning appears to be a false problem. The heterogeneity of the demographical, economical, territorial and cultural features of European countries revealed to be the determinant factors in the relevant risk policy-formulations processes. Can these differences being leveled by an equally effective method? Rather, these methods reflect them and respond to site-specific necessities that would be ineffective ignoring. The horizon of the research to be conducted in this field is therefore not the one of providing a model equally applicable to the constellation of diversities of European countries; but rather to provide decision-makers, and planners in particular, with the interpretational and operational instruments which are equally necessary to arrive to comprehensive and sound decisions.

Here, the declared limits of the research are not having extended the investigation to other forms of hazards and risks relevant to land use planning and not having verified its findings against the different dangerousness of the substances regulated by the Seveso Directives. However, the first trajectory would have weakened the possibility of providing a focused comparison of different national orientations due to the variety of legislations and risk-fields to be explored; the second would have deviated the course of the research towards a technical rather than policy-oriented development.

The findings collected in this book balance the two perspectives by providing, on the one hand, an analysis of the horizons of the European regulation relevant to an increasingly crucial form of technological risk and, on the other hand, an interdisciplinary perspective on the matter of its prevention suitable to find application in other forms of "risk in society".

Here, bridging the gap among different *interpretations of* and *perspectives on* risk is the main challenge. One of the lessons learned from this 5 years of PhD research is that the meaning of the concepts gravitating in the universe of risk is differently interpreted by different parties. The *uncertainty* of chemical engineers is not the "uncertainty" planners will think about when involved in a discussion. Similarly, the *risk* analysts communicate about is not the same "risk" communities will perceive when involved in a public debate. Achieving a common understanding of these concepts doesn't pass through the adoption of one common definition; but rather through the understanding of the others' interpretations. Interdisciplinary research should be meant to provide the instruments to interact during inter-disciplinary discussions, not promoting the "right" disciplinary approach. In consideration of the cross-sector audience the book is meant for, the findings of the investigation are hence primarily a contribution in this direction.

Claudia Basta, April 2009

TABLE OF CONTENTS

INTRODUCTION

Risk, territory and society: introduction to a XX century conflicting relation

We believe that the urban and territorial planning disciplines
should and could give an important contribution
to the understanding of the last century
while proposing solutions to the conditions of risk
and of increased exposure and vulnerability
of our cities and regions

S. Menoni, Costruire la Prevenzione (English: Building Prevention), 2005

I.1 Why a book on major accidents risk and land use planning

Europe is a constellation of cities and villages of fascinating heterogeneity.

European society is a patrimony of diversities of inestimable value.

According to many, what this constellation of diversity has in common is its increased *vulnerability*. Climate change induced events are increasingly threatening coastal zones, where some of the most beautiful and culturally representative European cities – such as Barcelona, Venice and Amsterdam among others - are placed. Industrial areas and hazardous installations are increasingly interfaced with urban areas, whose development is constantly searching for a balance between land scarcity and residential and infrastructural demands. Historical world heritage cities such as Venice share the borders with mega industrial poles, witnessing in so doing a more recent, yet equally complex past. Key transportation and maritime nodes such as Rotterdam, a port-city with one of the highest population density of the continent, are contemporarily exposed to the risk of inundation, industrial pollution and major accidents. By their side, mainland urban areas are increasingly interconnected due to the development of network infrastructures – electricity, water and gas supplies, transportation routes, waste disposals and services – whose siting and sometimes very nature appear to be increasingly *critical*, both materially and politically.

Is the European territory increasingly *at risk*?

This is one of the questions addressed in this book. Certainly, the awareness of the risks posed by the technological developments which followed the Second War World is more diffuse than in the past, and it is nowadays at the centre of a lively political and social debate. *Critical infrastructures*, *vulnerable areas*, *natural* and *technological risks* are not abstract concepts of privileged use in the academia anymore. They are part of our daily language, they regularly compare in the newspapers from London to Athens and they are at the top of the European political agenda since the hazards associated to extreme climatic events, ultra-hazardous facilities, mega-infrastructures *and* our increasingly urbanized territory became evident by means of a series of

dramatic events, such as the inundations in Germany in 2002 and the tragic explosion in a fertilizer fabric in Toulouse in 2001.

These events represent the evidence of the *risks* our society is, and has in part always been, exposed to. Nevertheless they involve an increasingly high part of the European population due to the augmented urbanization, complexity and interconnection of the European *territory*. These two key-words – *risks* and *territory* – are hence the two coordinates along which the analysis collected in this book is developed. Scope of the investigation is providing a perspective on the matter of risk accounting its territorial dimension.

To do so, the investigation focused on one specific kind of risk: the risk of major accidents as regulated at European regulatory framework level, specifically by the European Seveso Directives on Dangerous Substances[1]. Art 12 of the Directive is the first European requirement calling Member States to "*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 policies"*.

The Directive doesn't provide a specific methodological guidance on how to implement Art 12. The requirement is hence differently transposed in national legislations, which are in many cases consistent with pre-established methodological orientations. The PhD project focused on the most representative among them, namely

1. The Netherlands,
2. The United Kingdom,
3. France,
4. Germany, and
5. Italy.

A first review of the methods, decision-making processes and risk-information systems developed in these countries to comply with the requirements of Art 12 appeared to reveal different cultural and political orientations rather than purely methodological choices. In the light of this remark, the book tried to reply to the following research questions:

- Which are the characterizing elements of the different national transpositions of Art 12?
- What determined the development of different methods for land use planning in "Seveso" areas in the relevant practices?
- Are different national approaches leading to different levels of prevention?
- How are political views and cultural orientations influencing their adoptions?, and
- Which is the role and which are the perspectives of the European regulation in the light of these differences?

Several European research projects tackled and are still trying to provide valuable responses to part of these questions. In 2004, the Major Accidents Hazard Bureau of the Joint Research centre of the European Commission launched a research program titled "Land Use Planning in the Context of MAHB and NEDIES"[2]. The program included an investigation of the

[1] The first Directive issued by the European Union was Directive 82/501/EEC, OJ L 230, 1982/08/05, at 1. This Directive is known as "Seveso I". The Directive was amended twice, respectively by Directive 87/216/EEC, OJ L 085, 1987/03/28, p. 36 and by Directive 88/610/EEC, OJ L 336, 1988/12/07, p. 14. In 1996 the Directive was repealed and eventually replaced by Directive 96/82/EC, known as "Seveso II". The first amendment of this version is Directive 2003/105/EC of the European Parliament and of the Council of 16 December 2003, OJ L 345, 31/12/2003. This book focuses mainly on the second Seveso Directive.

[2] MAHB is the acronym of the Major Accidents Hazard Bureau of the Joint Research Centre, the European Commission scientific body placed in Ispra, Italy; NEDIES is the Natural and Environmental Disasters Information Exchange System established within the institute. Refer to http://landuseplanning.jrc.it , last visited: April 2008.

European methods developed for implementing the land use planning requirement of the Seveso II Directive. A second European project funded under the 6th Framework Program of the European Commission investigated the possibility of achieving a European harmonized methodology for mapping multi-hazards situations at the scope of supporting land use planning decisions[3]. Within the same Framework Program, the research project Risk Bridge, coordinated by the Dutch Applied Research Institute TNO, investigated the possibility of achieving an integrated regulatory framework for governing 6 different forms of existing and emerging risks. Among the analyzed risks-fields, systemic risks such as climate change and nanotechnology and site-specific risks such as nuclear waste disposal and sediments are included[4].

Other European projects relevant to the matter of integrating risk prevention evaluations in land use planning are the research led by P. Schmidt-Thomé in 2006[5] and the ESPON Hazard project[6]. The main objective of these studies is the integration of multi-hazards and multi-risks evaluations within spatial planning practices in a European harmonized way.

The research findings collected in this book provided a direct contribution to the first three projects[7]. By looking at their common general objective, which could be reassumed as the search of a European cross-national framework suitable to integrate hazard and risk prevention evaluations within spatial planning practices, it can be concluded that the matter of bridging risk prevention and spatial planning is becoming an increasingly autonomous and defined research field in Europe.

By conquering increasing autonomy, this research field requires to policy-makers and planners in particular to acquire a number of new interpretational and operational instruments. Risk analysis, major accidents prevention and the different possible rationale of risk prevention policies are not ordinarily included in the curricula of the relevant disciplinary backgrounds. In particular, whereas risk is an intangible and inherently probabilistic phenomenon, spatial planning lead to rather tangible and deterministic results: how to conjugate the relevant evaluation practices and achieving, in so doing, the objective of a "safe" European territory?

This book wishes to provide a first contribution in this direction. Between the fall of 2004 and the end of 2007 a survey on the different European methods developed to implement the land use planning requirements of the Seveso Directives was performed under the coordination of the Major Accidents Hazard Bureau of JRC. This research was conducted in the context of the works of the European Working Group on Land Use Planning, re-appointed following a requirement of the 1st amendment of the Seveso II Directive. The investigation resulted in the supporting

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[3] Refer to *ARMONIA: Applied Multi-Risk Mapping of Natural Hazards for Impact Assessment*, online. Available at: http://www.armoniaproject.net . Last visited: April 2008.

[4] Refer to Risk Bridge, online. Available at www.riskbridge.eu . Last visited: November 2008.

[5] See P. Schmidt-Thomé and H. Kallio (2006), Natural and Technological Hazard Maps of Europe, in P. Schmidt-Thomé (eds), *Geological Survey of Finland*, Special Paper n. 42

[6] For the ESPON Hazard project refer to European Spatial Planning Observation Network (ESPON), Project 1.3.1, *Spatial Effects of Natural and Technological Hazards*, online. Available at: http://www.espon.eu/mmp/online/website/content/projects/259/655/index_EN.html. Last visited: April 2008.

[7] In the fall of 2004 the PhD project was involved in a scientific training p/o the MAHB institute of JRC (Ispra, Italy). In the course of 2006 the PhD project was included in the working packages of CODES, a project led by the Innovation and Environment Dept. of TNO Bouw (Delft, NL). TNO coordinated the Risk Bridge project in the course of 2007. The contribution of the PhD candidate in the context of this project is a minor contribution represented by the Working Paper referenced in footnote 12. In 2007 the PhD project was further included in the *Implementatie Risicomanagement* research programme of the Delft CLUSTER Research Consortium (Delft, NL). .

document *Roadmaps*[8], wherein an up-to-date overview of 5 national methods for land use planning in "Seveso" areas is provided[9]. The *Roadmaps* are a supporting document of the official Guidance for the implementation of Art 12; the Guidance was adopted by the European Commission in the autumn of 2006[10].

The findings collected in the Roadmaps documented, reported in Chapter 4 of his book, were integrated with additional literature in the course of 2008. This additional work provided the basis for the further contributions, specifically in regard to the comparison of the risk-mapping practices in The Netherlands and the United Kingdom[11] and the analysis of the several definitions of *risk* in use within different disciplinary contexts, European glossaries and legislations [12] respectively. The results of these studies are provided in Chapter 3.

In order to reply to the mentioned research questions, several investigations were further performed. The ethical principles applicable to analyze the scope and implementation of Directives such as the Seveso and the proposal of an ethical framework which may serve as guidance to their future developments are reported in Chapter 3. A comparison between the different methods developed in 4 of the 5 selected European countries by means of a GIS software application is reported in Chapter 5. In the same Chapter, the cultural theories of Geert Hofstede are applied to the analysis of the relevant national risk prevention policies in order to address some considerations on their recognizable "cultural basis".

Before providing a summary of the main conclusions of the investigation, some of the choices which have influenced its trajectory are explained. The first is the choice of focusing on one specific type of risk rather than performing a more general analysis of the matter of "risk in land use planning". This choice derives from the opportunity offered by the MAHB research programme of contributing to the development of supporting instruments for implementing Art 12 in the Union. Extending the research to other forms of hazards and risks relevant to land use planning would have represented a potential deviation from this objective: reviewing the relevant high number of regulations, legislations and practices would have surely weakened the possibility of performing a focused comparison. Furthermore, the matter of major accidents risk has received less, though increasing attention in the last decades in comparison to other "traditional" risk-fields, such as flood and hydro-geological risks. The first comprehensive study investigating different European methods and regulations in the field of major accidents dates back to 1997[13]; since then only few studies were published. Finally, the nature of technological risk is substantially different than the nature of natural hazards. Even if their distinction shall be considered more nuanced than in the past[14], it is indubitable that the prevention, perception and regulation of technological risk

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[8] C. Basta, M. Struckl and M.D. Christou (2008), *Implementing Art. 12 of the Seveso II Directive: Overview of Roadmaps for Land Use Planning in Selected Member States*, EUR23519 EN

[9] C. Basta, M.Struckl and M.D.Christou (2008), *op.cit*

[10] EWGLUP (2006) *Guidance on the implementation of Art 12*, MAHB (*eds*.), Joint Research Centre of the European Commission, Online: http://landuseplanning.jrc.it. Adopted by the Commission Decision C(2007)2371.

[11] C. Basta, J. Neuvel and S. Zlatanova (2006), Risk-Maps Informing Land Use Planning Processes, Journal of Hazardous Materials, Vol. 145, No.1-2, 241-249

[12] C. Basta *et al* (2007), *Beyond Uncertainty, Managing Controversies: an Integrated Governance Model for Managing Existing and Emerging Risks. Experience of a European Project*, Working Paper of the Risk Bridge Project, online. Available at www.riskbridge.eu. Last visited: April 2008

[13] A. Jones (1997), *The Regulation of Major Hazards in France, Germany, Finland and the Netherlands*, Health and Safety Executive (eds), UK

[14] As it will be explained in the following, this remark refers to the phenomenon of climate change, whose manifestation into augmented magnitude and frequency of natural disasters appear to be enhanced by the impacts of technological activities.

differ in nature for a number of factors. The opposition between *risk posers* and *risk runners*, with all the relevant ethical, regulatory and social aspects, and the possibility of governing their interface by means of, among other measures, a proper territorial dislocation of hazardous industries are the main ones.

In the light of these considerations, while offering a perspective on one specific type of technological risk the book wishes to provide more key-of-readings of the matter of risk in land use planning to the cross-sector audience of planners, policy-makers and European and national regulators the PhD project has interacted with during its development. The heterogeneity of the investigated research questions confers, on the one hand, a character of generality to the conclusions; on the other one, it will open to a number of interesting and multi-disciplinary research horizons. Both are described in section 1.3 of this Introduction; in the following, an introduction to the matter of risk and land use planning in the context of the European regulation is given.

I.2 Risk, territory and society in the European regulatory framework: a first insight

In Europe, the first legal requirements addressing the matter of siting dangerous establishments consistently with risk prevention purposes were issued between the 70's and the 80's of the past century. However, specific *land use planning policies* started to be object of regulation only in recent years, when the lessons learned from accidents such as Bhopal (1984, India) and Toulouse (2001, France) started to be reflected in the policy-formulation processes of the Union.

Is the European a *post-disasters* regulation?

Surely, industrial accidents of disastrous consequences augmented dramatically in the second half of the last century. The development of the new forms of chemical substances and energy technologies on a large scale has largely contributed to their augmented destructive potential. Although it would be mistake concluding that the phenomenon of "industrial risks" dates back to few decades ago, and that the "society systematically dealing with risk" epitomized by Authors as Ulrich Beck was born only then[15], it is indubitable that the disastrous potentials of the last generation of industrial technologies is of ever known magnitude. As a matter of fact, new regulations and laws were prompted by their increased dangerousness together with their capillary diffusion, as in the case of LPG storages and chemical facilities in the early '70's (Ale 2005)[16]. Significantly, these regulations were issued in the same countries which have known the earliest industrial development together with the most rapid urban growth, such as The United Kingdom, France and The Netherlands (Basta *et al* 2008).

The name of the first European regulation addressing the matter of land use planning in areas exposed to industrial risks derives from an Italian village wherein in 1976 a "paradoxical classic disaster" occurred (De Marchi and Funtowicz 1996)[17]: Seveso. The accident at the ICMESA establishment occurred, more precisely, in Meda, a small village in the North of Italy. The accident provoked a massive release of dioxin in the atmosphere and toxic clouds reached the Municipality

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[15] See in particular U. Beck (1992), *Risk Society: Towards a New Modernity*, London, Sage Publication. A comprehensive analysis of the works of Beck will be given in Chapter 1.

[16] B.J.M Ale (2005), Living with Risk: a Management Question, Reliability Engineering and System Safety, No. 90, 196-205.

[17] B. De Marchi, S. Funtowicz and J. Ravetz, "Seveso: A Paradoxical Classical Disaster", in J. Mitchell (eds.), *The Long Road to Recovery: Community Responses to Industrial Disaster*, United Nation University Press, online. Available at: http://www.unu.edu/unupress/unupbooks/uu211e/uu211e00.htm Last visited: April 2008

of Seveso. The top-event[18] of the accident was an exothermal reaction that, increasing the pressure in a vessel, caused the breaking of a safety valve[19]. The rupture of the valve provoked a massive release of 2, 3, 7, 8 –tetracholorodibenzo-*p*-dioxin, best known as dioxin. The population was affected by serious injuries, among which the most evident and persistent was a form of *chloracne* (a deforming skin disease). Although no immediate deaths occurred, preventive abortions were allowed to pregnant women. Thousands of animals were slaughtered to prevent the contamination of the food chain; the (uncalculated) environmental consequences have been object of investigation and monitoring until the recent years[20].

Though not the first of its kind in Europe[21], the accident had an international resonance and became representative of a "new" form of threat: *dangerous chemical industries*. Until the occurrence of the accident the population living in the surrounding of the ICMESA establishment was barely aware of the kind of chemical substances they nay have been exposed to. The establishment was nicknamed by the population the *perfume fabric* which, as already noticed, had a rather gentle connotation[22]; unsurprisingly, also the first-aid services which provided the first treatments to the injured were poorly prepared to cope with the health effects of dioxin – everything but a perfume.

Risk, *territory* and *society* appeared, though not for the first time, to be intimately interconnected in the dynamic of this accident. In 1982 the European Union responded emanating the first Directive addressing the matter of major accidents involving the release, fire or explosion of substances dangerous for humans. 1982 is hence the year in which a long and debated policy-formulation history began: a history which developed as a *lesson learned from accidents*, which kept occurring in European as extra-European countries in the following decades.

In 1984, the most tragic chemical disaster of history occurred in Bhopal, India[23]. The massive release of methyl-isocyanate from a fertilizers fabric sited in the "black valley" of the capital of the Madhya Pradesh provoked the death of a number of people estimated between 2000 and 20.000 (Arcuri 2005, Lees 1996, Shrivastava 1996). The majority of deaths and injuries affected the population living in the slums amassed along the borders of the establishment.

The amount of literature over this accident is impressive. According to a number of examined investigations, the tragedy was provoked by the inactivity of basic safety measures. Some of them were left in a state of inactivity following a costs-cutting policy that the company had implemented during the last years of its operation. As a consequence, the supposed top-event of the accident appears somehow incredible: the intrusion of water within one of the methyl-

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[18] A top-event is the selected outcome of a chain of failures whose possible causes are explicated by means of cause-consequence analysis (fault-tree analysis). Refer to D. Jones, *IChem^E - Nomenclature for hazard and risk assessment in the process industry*, HSE (eds.), Institute of Chemical Engineers, 1996, UK. Reported in L. Fabbri, *EWGLUP Glossary*, JRC (eds.), 2000, Italy.

[19] Refer to A. Arcuri, *op. cit*., at 210. The accident of Seveso will be further analyzed in Chapter 1, where I provide a technical analysis of the accident together with a discussion over its "impacts" on the following developments of the territory.

[20] Detailed references are given in Chapter 1.

[21] B. J. M. Ale reports a detailed inventory of accidents occurred in the last decades, like the accident in a LPG storage facility in Feyzin, France, where 18 were killed (1966); the similar accidents in Flixborough, UK, killing 28 people (1974) and in Beek, The Netherlands, killing 14 (1975). Refer to B.J.M Ale (2005), *op. cit*.

[22] A. Arcuri (2005), *Governing the Risk of Ultra-Hazardous Activities: Challenge for Contemporary Legal Systems,* PhD Thesis, Rotterdam Erasmus University;

[23] One of the most documented analyses of the causes of the accident of Bhopal is that of D. Kurzman (1987), *A Killing Wind: Inside Union Carbide and the Bhopal Catastrophe*, New York, McGraw Hill. Other studies beside those examined by Arcuri are mentioned in Chapter 1.

isocyanate (MIC) tank storage, which protective coffin exploded under the pressure caused by the expansion of the highly unstable substance. None of the most elementary safety measures were in place: the two tank storages which should have allowed a rapid transfer of the MIC in emergency cases were filled; the refrigerators unit had been shut down the same year; the two vent gas scrubbers were not working. The release of MIC in the atmosphere encountered practically no resistance.

The number of deaths is still object of uncertainty, but is surely comprised between 2000 and 20.000 when considering the 15 years following the accident. The list of environmental, social and economical consequences is indeed incalculable. One sure factor of the impressive number of injured and deaths was the vicinity between the slums of the municipality of Bhopal and the very borders of the establishment: during the 60's, the possibility of working for the company and of benefiting from its induced markets attracted a number of poor immigrants, whose first shelter on arrival in town was usually a provisional recovery in the vicinity of the establishment.

Leaving the in-depth description of the accident of Bhopal to Chapter 1, in this Introduction I would like to give a chance to a "non-academic" contribution to shed some light over some non secondary aspects of the tragedy. The contribution I refer to is the world famous book of Dominique la Pierre *Il etait minuit cinq a Bhopal*[24], written by the French reporter after a detailed investigation over the dynamic of the accident and the collection of interviews of a number of survived[25].

In the account of La Pierre, the tissue of the governmental and Union Carbide agreements for the location of the plant within the "black valley" at the periphery of the city of Bhopal, capital of the state of Madhya Pradesh, is accurately weaved. What is even more accurately described is the perception of the residents of the valley, the firsts who were reached by the toxic clouds, about the installation and the activities of the establishment: the fabric was a gift of divinities. The possibility of a regular salary, coupled with the practically complete ignorance of the dangerousness of the treated substances, enhanced the perception of the fabric as a truly *manna from sky*. Despite a governmental attempt of clearing the surroundings of the establishments by the so-called *encroachments,* the slums remained in place and augmented their density until the night of the tragedy, the 2nd of December 1982.

La Pierre documents that according to the Municipal Urban Plan, any establishment causing toxic emissions in areas wherein predominant winds were blowing in the direction of urbanized areas should have not been allowed. Evidently this urban regulation was, simply, ignored. Consequently, the densely populated district of Bhopal can be regarded as a *precondition of the disaster*.

This remark, which could appear banal, is fundamental to the understanding of the disaster and of its contribution to the following European regulatory developments. The replacement of the first of the Seveso Directive with Directive 96/82/EC does in fact recall the Indian accident

[24] The American edition of the work of the French journalist is D. La Pierre and J. Moro (2002), *Five Past Midnight in Bhopal: the Epic Story of the World's Deadliest Industrial Disaster*, New York, Warner Books. Also Arcuri recalls the investigation of La Pierre, particularly regarding the history of the discovery of *Sevin*, the miraculous fertilizer invented at the Boyce Thompson Institute in Yonkers, New York, by the then Union Carbide Ltd and produced also in the establishment of Bhopal.

[25] La Pierre arrived in Bhopal 16 years after the tragedy and his account, though of indubitable journalistic quality, refers to a period significantly far from the emergency. However, this allowed La Pierre to examine an amount of documents and studies which were obviously absent at the time of the accident. His conclusion regarding the causes of the accident is that of human error and not, as representatives of Union Carbide communicated to the media in the immediate aftermath of the accident, of sabotage. This position is the same of Kurzman. Refer to D. Kurzman (1987), *op. cit*., particularly at 39-57.

explicitly; Art 12 requiring the control of urbanization in the areas falling under the domain of the Second Directive was introduced. The Article reads as follow:

> *[…] "Member States shall 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 policies. They shall pursue those objectives through controls on:*
> *(a) the siting of new establishments,*
> *(b) modifications to existing establishments covered by Article 10,*
> *(c) new developments such as transport links, locations frequented by the public and residential areas in the vicinity of existing establishments, where the siting or developments are such as to increase the risk or consequences of a major accident.*
> *Member States shall ensure that their land-use and/or other relevant policies and the procedures for implementing those policies take account of the need, in the long term, to maintain appropriate distances between establishments covered by this Directive 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 and, in the case of existing establishments, of the need for additional technical measures in accordance with Article 5 so as not to increase the risks to people."*[26]

The innovative character of Art 12 consists in the explicit acknowledgment of the role of land use policies as a fundamental element of the prevention of industrial disasters. In so doing, Art 12 confers a "prevention and control" function to land use planning instruments.

However, other lesson had to be learned from accidents.

In 2000 an explosion in a fireworks' storage killed 22 people and injured 900 in Enschede, The Netherlands (Bottleberghs 2000, Ale 2005). In 2001, a second explosion of ammonium-nitrate based fertilizers killed 30 people and injured 3000 in Toulouse, France (Salvi 2004, Cahen 2006). In both cases, environmental and territorial damages affected a vast area surrounding the establishment. In Toulouse, damages were reported up to 7 km away from the crater left by the explosion. This disastrous scenario was not accounted within land use planning instruments.

The European Union did not ignore the signal value of these accidents. Within the Resolution famous as the Resolution of Toulouse[27], the impossibility of the "0 risk" posed by hazardous industrial activities and storages was formally acknowledged. In 2003, the first amendment to the Seveso II Directive extended the domain of its requirements while stressing the need of *long-term land use policies* in the area subject to major accidents accounting and preventing their consequences. The Commission was invited to elaborate supporting instruments assisting Member States in their land use evaluations.

In order to achieve this objective, the amendment called for the re-appointment of the Working Group on Land Use Planning[28]. The EWGLUP started its activity in early 2004 under the

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[26] See Directive2003/105/EC of the European parliament and of the Council of 16 December 2003, *op.cit*, Art 7 (a)

[27] Resolution of the EU parliament on the explosion of a plant in Toulouse , B5-0611, 0612, 0614 and 0615/2001.

[28] The TWG5, i.e. the Technical Working Group on Land Use Planning, was firstly appointed in 1997. An account of the works of the Technical Working Group 5 and the other Technical Groups active in the period

coordination of the Major Hazards Accident Bureau of the European Commission. In 2006, the Guidance for implementing Art 12 of the Seveso II Directive was formally adopted[29].

The adoption of the Guidance concluded a history of 30 years: *30 years of lessons learned from accidents*. The European Commission was invited already by the Council Resolution of 16 October 1989 to include provisions on the control on land use planning in the first Seveso Directive[30]. However it took several more years before achieving a concrete result.

There are many possible explanations of this delay. One of them is that siting new and modifying existent Seveso establishments while planning land uses in their surroundings *compatibly* is *per se* a complex matter: plants pose a risk to which prevention the scarcity of land poses a limit. This limit determines the "decisional space" within which the presence of hazardous industries and of urbanized areas strives for a balance between economical prosperity and the safety of humans and the environment. A second reason, equally relevant but less easily demonstrable, is the fact that so-called *existing situations*, i.e. those situations in which Seveso establishments have been surrounded in time by densely populated urban areas, have most probably discouraged the provision of stringent requirements[31].

The conclusions of these 30 years of *lessons learned from accidents* is the starting point of the research collected in this book. The implementation of Art 12 of the Seveso II Directive in national legislations has in fact revealed to be significantly different. Different pre-existent legislative orientations and spatial planning systems have led to the adoption of different rationale and methods for implementing the new requirement. Is it possible to arrive to a rigorous explanation of these differences? Which are the deriving limits and horizons of the joint European risk prevention regulation? What sets the boundaries between the national and the supra-national governance of risk?

What can a scientific contribution provide in regard?

I.3 Framework and contributions of the study

As mentioned above, in 2004 the Joint Research Centre launched the MAHB and NEDIES research programme, in the context of which most of the research collected in this book was conducted. The survey on the different methods developed by member States for implementing Art 12 of the Seveso II Directive, stating the *Control of Urbanization* requirements, was initiated in the fall of the same year, when the works of the European Working Group on Land Use Planning started.

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comprised between 1997 and 1999 is in R. Gowland (1999), Is the Seveso II Directive an improvement of its predecessor? A chemical industry safety professional's personal view, Journal of Hazardous Material, Vol. 65, pp. 15-22. In his paper Gowland seems to foresee the outcomes of the second Working Group when he writes […] *A majority of States have appropriate but distinctly different policies. (...) a minority of States has no discernable policy related to "hazardous" industrial development beyond the concept of nuisance. (...) The outcome* (of the working group) *is most likely to be a "shopping list" of possible policies from which these states could choose. The others could politely ignore the list because their policies already work well for them and the industry understands and accept them* […]". The Author didn't fail too much in his prevision. This will become clear in the conclusions of this book.

[29] M.D. Christou, M. Struckl and T. Biermann (2006), *Land use Planning Guidance in the context of Article 12 of the Seveso II Directive 96/82/EC*, etc, online. Available at http://mahbsrv.jrc.it/downloads-pdf/LUP%20Guidance-2006.pdf . Last Visited: September 2008

[30] Council Resolution on Guidelines to reduce technological risks and hazards, in OJ C 273, 26.10.1989, at 1.

[31] In this regard, it is important to notice that the Seveso Directives have no retroactive effect; the regulation addresses only new establishments, their modification or new urban developments in their surroundings.

The mandate of the EWGLUP was providing additional policy and technical instruments supporting member States in achieving the objective indicated by Art 12. The works of the group were organized accordingly to 5 different objectives, namely:

1. Giving the principles of "good practice" in Land-Use Planning and describe the underlying principles of risk/hazard assessment that will support this (e.g. consistency, transparency, robustness, etc);

2. Developing a technical database of scenarios and data that may be used in risk/hazard assessment approaches assessing the compatibility between the establishments covered and the sensitive areas listed in Article12, containing in particular: accident scenarios; event frequencies; commonly agreed definition of risk-related indices/measures which are of main concern for land-use planning purposes and therefore serve as the basis for relevant decisions; methods for their calculation; commonly agreed ranges of data/parameters; criteria applied for the definition of separation distances; and identification of land development restrictions that may be applied in the land-use planning zones. Moreover, define a suitable scheme for revising/updating information in this database;

3. Examining and identifying potential additional safety measures and where possible their relative costs that can be applied for the purposes of Land-Use Planning. Examine the effectiveness of "hardware" and "soft" safety measures;

4. Identifying strategies that address pre-existing situations of concern between Seveso sites and residential and other sensitive areas, taking into account the role of technical measures and emergency plans, and

5. Assessing in particular whether the information provided in the Notification for lower-tier sites (and even in the Safety Report for upper-tier sites) is sufficient or it has to be revised.

The research collected in this book is particularly relevant to objective 1. At this scope a preliminary investigation of the different legislations and methods in place in the Union for implementing Art 12 was performed. Based on a questionnaire-based survey[32], the investigation included the then 25 Member States of the Union[33]. The questionnaire was hence addressed to the 25 national delegations represented within the EWGLUP. In consideration of the then undergoing development of some European legislations (like the French one), the survey monitored the period comprised between the fall of 2004 and the summer of 2007, when the last plenary meeting of the EWGLUP took place in Luxemburg. The findings of the investigation were integrated with the scientific literature published up to the first half of 2008 and were published as JRC Technical Report in the fall of the same year[34].

Chapter 4 of this book replicates the structure of the JRC Technical Report and reports its main findings, particularly regarding the 5 country-profiles derived from the questionnaire-based survey, interviews and literature. The information reported in the 5 country-profiles was updated until the summer of 2007; the verification of and integration with relevant literature was performed until the first half of 2008. The inventory of dangerous establishments and other aspects of national regulations may have undergone minor changes after the second half of 2008; however, the country-profiles shall be regarded as an up-to-date portrait of the analyzed 5 countries methodologies.

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[32] A copy of the questionnaire is reported in Annex I of Chapter 4 of this book

[33] The investigation and the collection of results in the relevant JRC Technical Report *Roadmaps* was performed under the coordination of Doctor Michalis Christou, Head of the Major Accidents Hazard Bureau of the Joint Research Centre of the European Commission, and of Doctor Michael Struckl, National Seconded Expert of the Institute in the period comprised between 2004 and the summer of 2007.

[34] C. Basta *et al* (2008), *op. cit*.

Whereas the MAHB investigation ended with reporting the most relevant differences among them, the PhD project tried to explain them. This book does hence insert the results of the JRC investigation in a broader research context and in so doing aims at reaching a wider audience than the European regulator.

To do so, Chapter 1 starts with providing a set of guiding definitions relevant to the matter of risk in land use planning[35]. These definitions are functional to support the reading of the book by the side of the Reader less familiar with the terms in use in the field of risk prevention. Different definitions of risk and its counterparts are analyzed together with several relevant terms in use in literature. In so doing, different perspectives on the matter of technological risk prevention are introduced. Here, the works of Arcuri, Beck and Renn are used to address fundamental legal and sociological considerations on the matter of governing risk. The paradigm of "risk society" (Beck 1992) is discussed and some of its controversial interpretations are resolved by providing important distinctions among different types of risks, namely natural vs. technological and systemic vs. site-specific.

Chapter 2 is a rather narrative part of the book, wherein world famous major accidents and the relevant *lessons learned* are described. Here the works of Amendola, Ale, Lees and van Breugel provide the main references for addressing the issue of land use planning in Seveso areas from a risk analysis perspective. Through the analysis of the works of these Authors and the deriving elaborations the Chapter provides the definitions and assumptions the book kept referring to in the course of its development[36]. In particular, the limits of a mono-dimensional characterization of risk in land use planning are discussed and the adoption of a multi-dimensional characterization of the consequences of accidents is proposed.

In Chapter 3, the analysis of the regulatory developments of the Seveso Directives from 1982 to 2006 and of the "lessons learned from accidents" translated in their scope and requirements follows. These *lessons* are observed through the multi-dimensional lenses adopted in the previous Chapter: would have the mere calculation of the "essence of risk" equation led to the consideration of the political, ethical and social consequences of accidents like the one occurred in Bhopal in 1984? This question opens to the ethical reflections collected in the Chapter. The ethical principles applicable to the governance of major accidents risk and the liability issue to them associated are therefore discussed. Here, the works of Ersdal and Aven (2008), Petterson and Hansson (2004) and Moroni (1997), applying the concepts of residual moral obligations and "safety as spatial benefits" to the ethical analysis of siting controversies are used as reference for analyzing the scope and underlying obligations of the Seveso Directives. An ethical framework suitable to provide guidance to their further developments and conclusions over the desirability of a regulatory system based on *ex-ante* regulations and *post-event* liability rules are derived.

Chapter 5 is the core of the book. Here, the research investigates the variables (quantitative vs. qualitative) which may explain the different methods and policies described in Chapter 4. In particular, probabilistic vs. deterministic methods are compared by means of the case-study of section 5.2. Published in 2006, the case-study applies 4 of the 5 national methods to the land use planning evaluations relevant to an Italian industrial area. The case-study is performed by means of

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[35] The definition of land use planning adopted in the context of the EWGLUP works reads "*the systematic assessment of land and water potential, alternative patterns of land use and other physical, social and economic conditions, for the purpose of selecting and adopting land-use options which are most beneficial to land users without degrading the resources or the environment, together with the selection of measures most likely to encourage such land uses. (...) It includes participation by land users, planners and decision-makers and covers educational, legal, fiscal and financial measures*". This definition is the one also this book refers to. See L. Fabbri (2001), *EWGLUP Glossar*y, MAHB.

[36] Detailed references of the mentioned contributions will be provided in the relevant Chapters.

the Aripar-GIS software application[37]. The different outcomes are compared and a discussion of their compliance with the scope and requirements of Art 12 is developed. The discussion focuses on the prioritization of hazards reduction measures that follows the application, in particular, of the French and Dutch methods[38]. In so doing, the outcomes of the much debated consequence-based and risk-based methods are discussed. Whereas the first approach reveals to be more sensitive to the hazardous substances inventory, and therefore an incentive to its reduction by decrease or dislocation, the second appears to incentive the increase of the safety performance of establishments and the reduction of vulnerability of the surrounding areas. It can be therefore generally concluded that it is the underlying *scope* and not *the result* of land use planning evaluations that appears to determine the adoption of one of the two methods. Here, the demographic variable may be a determinant factor. In countries with high population density, major land scarcity and diffuse presence of industries, the adoption of a deterministic method for land use planning evaluations would result economically difficultly viable. In these contexts, land use planning evaluations become hence instrumental to the reduction of the probability of accidents and the installation of additional technical measures (ATM) rather than to the decrease of the hazardousness or dislocation of establishments.

In this perspective, the choice between the two orientations confirms to be influenced by the political and territorial context of regulations rather than by mere methodological considerations; the room for European harmonization, rather than by an equally applicable method, seems hence to be represented by the reference to a common set of accident-scenarios rather than to a common approach to their evaluations for land use planning purposes[39].

A following comparison focuses on the different risk-mapping methods developed in 2 of the analyzed countries, namely The Netherlands and the United Kingdom[40]. The study, published in 2006, explores the different risk-informative systems in place for supporting land use planning evaluations in Seveso areas. Here, a different interpretation of the "right to know" and "need to know" in the roman and common law systems may explain the relevant differences.

A third and somehow complementary analysis focuses on the cultural variables which may have influenced the adoption of different approaches to the overall matter of land use planning in Seveso areas, in particular the adoption of probabilistic vs. deterministic orientations. Here, the cultural theories of Hofstede are used as a reference for addressing some interesting conclusions on the existence of a "cultural orientation" in risk prevention policies. The European national cultures classified as uncertainty-adverse by the Dutch sociologist correspond to the legislative contexts in which a semi-quantitative or deterministic approach are prescribed. Even here, risk regulation reveal to be an inherently "national issue".

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[37] V. Cozzani, R. Bandini, C. Basta and M.D. Christou (2006), Application of Land-Use Planning Criteria for the Control of Major Accident Hazards: A case-study, Journal of Hazardous Materials, Vol. 136, 170–180. I wish to clarify that the parts of the case-study to which I gave my contribution are the sections relevant to the description of the European legislations, the deriving methodological approaches and the conclusions derived from their comparison.

[38] The French method applied in the case-study refers to the French regulation in place before July 2003. This method is consequence-oriented. After this date, the French regulator issued a new regulation prescribing a semi-quantitative approach. However, the scope of the case-study was comparing consequence vs. risk-oriented methods; furthermore, at the time of its elaboration the French regulation was in a dynamic status of development and not available in a definitive form.

[39] However, the book doesn't further investigate in this direction. A proposal of a set of common reference scenarios for land use planning evaluations is offered by the Guidance for implementing Art 12 of the Seveso II Directive mentioned above.

[40] C. Basta *et al* (2006), *op. cit*.

The conclusions collected in Chapter 6 summarize the findings discussed in the course of the previous Chapters. The ethical, legislative and cultural elements determining different "roadmaps" for land use planning in Seveso areas are discussed. The main research question replied in this section regards the "limits and horizon" of a joint European regulation in the light of these sometimes remarkable differences. In principle, whereas legitimate cultural and political orientations determine the adoption of different methods to resolve the matter of risk in land use planning, the European regulation holds the responsibility of providing Member States with a cross-national regulatory framework suitable to overcome the limits of national-based legislations. Industrial major accidents are potentially trans-frontier phenomena; furthermore, the obligations deriving from the scope of Directives such as the Seveso are necessarily cross-cultural moral obligations. Can they and the instruments to comply with them be better reflected at European framework level?

Here, several indications are provided. The first is the proposal of adopting a multi-dimensional definition of (the consequences of) risk at European framework level. In the text of the Seveso Directive, risk is defined as *"the likelihood of a specific effect occurring within a specified period or in specified circumstances"*[41]. Being the general scope of the Directive *limiting the consequences of major accidents to man and the environment*, national legislations provide criteria for "measuring" these consequences in terms of health effects and, in some cases, loss of environmental patrimony. In simple words, the consequences of the risk of concern are generally mono-dimensional: the deaths of humans is what need to be prevented.

As argued in Chapter 2, the consequences of the accidents that influenced the development of the European regulation would have not been "captured" by this characterization. Bhopal remains sadly famous in history for having led to question the ethical reliability and the very desirability of the chemical industry, and for having highlighted the limits of the legal instruments and resources at disposal for compensating the social, environmental and hence long-term damages provoked by the accident. *Sensitive* risk policies (Arcuri) should therefore address the matter of risk in the multi-dimensional perspective of their overall tangible and intangible consequences in order to incentive a more sound consideration of the measures to be put in place for their prevention. The definition of risk proposed in Chapter 1, reading "*risk represents the possibility of losses or disruption of lives, goods and options humans value*" is a proposal in this direction.

A second indication comes from the results of the ethical reflections developed in Chapter 3.

Here, the paradigm of risk society of Beck is discussed at the scope of verifying its consistency with the matter of major accidents risk as regulated by the Seveso Directives. The main conclusion of this discussion is that technological risks *not tied to the place of origin* and *unlimited in time and space* are surely represented by nuclear risks; but are not equally representative of the industrial risks falling under the Seveso regulation. Here, the relevance of defining the intergenerational term of the consequences of accidents emerges. The difference between nuclear and non-nuclear technologies appear to be marked by this characterizing element of their possible consequences. Furthermore, whereas in the first case the consequences are indeed systemic (they overcome the spatial dimension), in the second case they're often confinable within a given spatial and time extension.

These reflections opened to the ethical considerations addressed in the following of the Chapter. The moral obligations of informing, improving and compensating are surely relevant to the scope of the Seveso Directives. However, whereas the first is explicitly mentioned in the relevant text and the second explicitly mentioned in the corpus of regulations complementary to the

[41] See the text of Directive 96/82/EC, Art 3 (7), *op. cit*.

mandate of the Directives[42], the obligation to compensate found minor consideration. Here, the concept of *safety as spatial benefit* derived by Moroni and discussed in Chapter 2 may represent a "way forward[43]". Site-specific residual risks lead to an unequal distribution of safety in society; levelling such inequality is only possible by means of the allocation of additional spatial benefits. Whereas some recent national legislations address this problem explicitly (see the French country-profile reported in Chapter 4), a concrete indication at European level to enforce this obligation is missing.

A third consideration regards the methodological orientations of European countries. The much debated adoption of probabilistic vs. deterministic methods and the search of an equally applicable method to resolve the matter of industrial risk in land use planning appears to be a false problem. The heterogeneity of the demographical, economical, territorial and cultural features of European countries revealed to be the determinant factors in the relevant risk policy-formulations processes. Can these differences being levelled by an equally effective method? Rather, these methods reflect them and respond to site-specific necessities that it would be ineffective ignoring. The horizon of the research to be conducted in this field is therefore not the one of providing a model equally applicable to the constellation of diversities of European countries; but rather to provide decision-makers, and planners in particular, with the interpretational and operational instruments which are equally necessary to arrive to comprehensive and sound decisions.

Here, the declared limits of the research are not having extended the investigation to other forms of hazards and risks relevant to land use planning and not having verified its findings against the different hazardousness of the substances regulated by the Seveso Directives. This is discussed in the following section, which concludes the Introduction of this book.

I.4 Limitations of the study and research horizons

As before mentioned the book builds upon previously published contributions of different nature, namely 1 JRC Technical Report, 2 peer-reviewed articles and 1 Working Paper. The findings of these contributions were reorganized and inserted in the wider context of the additional studies performed between 2007 and 2008 in the context of the PhD research.

The overall result fills a gap in the literature addressing the matter of land use planning in at-risk areas. However, the variety of the aspects addressed in the course of the research led to finalize a book, on the one hand, of inevitable generality and on the other one of extreme specificity.

This two-fold character of the book results from a number of choices. As explained before, the first and most evident is the choice of focusing on one specific kind of technological risk relevant to land use planning rather than extending the analysis to crucially relevant hazards, for example climate change induced-events. The second is not having explored the matter of major accidents from a more technical perspective, verifying the findings of the study against the different hazardousness of the chemical substances object of the Seveso regulation.

The first choice was explained at the beginning of the Introduction. The second can be motivated by recalling the audience the book is meant for, which is the cross-sector audience the PhD project has interacted with in the course of its development. Within this audience, planners and policy-makers revealed to be those more interested in acquiring the interpretational instruments suitable to empower them in tackling the matter of land use planning in Seveso areas. Whereas it is

42 See in particular the part of the Seveso II Directive recalling Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work, Art 2 (2).

43 S. Moroni (1997), Etica e Territorio, (English: *Ethic and Territory*), FrancoAngeli, Milan

indubitable that this passes through the understanding of the specificities of the problem, it is questionable whether they should acquire the overall knowledge necessary to look at the matter of accidents from a rigorous analytical perspective.

Inter-disciplinary research should be meant to provide the instruments for interacting during inter-disciplinary discussions, not for invading others' disciplinary domains[44]. The engineering perspective on the matter of major accidents risk is obviously necessary to frame the problem of siting dangerous industries and regulating land use planning in their surroundings correctly; however, the predominance of this perspective has been by more parties recognized as one of the limits of risk decision-making processes[45].

One of the lessons learned from this 5 years of PhD research is that the meaning of the main concepts gravitating in the universe of risk is differently interpreted by different parties. The *uncertainty* of chemical engineers is not the "uncertainty" planners will think about when involved in a discussion. Similarly, the *risk* analysts communicate about is not the same "risk" communities will perceive when involved in a public debate. Achieving a common understanding of these concepts doesn't pass through the adoption of one common definition; but rather through the understanding of the other's interpretations. This book is hence primarily a contribution in this direction.

Among the several research horizons indicated by its findings, the ethical and sociological reflections addressed in Chapter 1, 2 and 5 are the most promising basis for a prosecution of the research towards a philosophical rather than a technical direction. In front of contemporary technological risks, ethics can guide more sounds decisions than any detailed modelling and analyses. However, also ethics has its own orientations and different currents would lead to rather different reflections. A radically utilitarian one does inevitably lead to balance safety against its costs; a radically deontological one does inevitably lead to question whereas these costs are ever "low enough" to justify the acceptance of man-induced risks. The optimal ethical orientation in risk studies is therefore the one balancing the two perspective by accepting, in principle, that risks are the intangible counterparts of all tangible human activities, and that in front of their prevention, a *post*-risk society empowered to govern them is an informed society where the will of achieving a *as more equal as possible* distribution of benefits doesn't sound as an outdated and unrealistic purpose; but as its own very mandate.

[44] The case-study reported in Chapter 4 is a successful example of this interaction.

[45] See for example T. Horlick-Jones (1998), Meaning and Contextualization in Risk Assessment, Reliability Engineering and System Safety, V.59, 79-89

CHAPTER 1

The paradigm of "risk society" and the matter of defining risk

We Athenians in our persons, take our decisions
on policy and submit them to proper discussion.
The worst thing is to rush into action before
the consequences have been properly debated.
And this is an other point were we differ from other people.
We are capable at the same time of taking risks
and estimating them before hand

Thucidides, 431

The Chapter starts with providing an historical background of the matter of siting dangerous industries. After having argued how the nature of their dangerousness has changed in the past decades, the paradigm of "risk society" of Ulrich Beck is analyzed in-dept and some distinctions among the several kinds of risk object of his analysis are made. In particular, I will clarify some important differences between nuclear and other kind of industrial risks. Whilst Beck seems to consider nuclear risks as representative of the general phenomenon of industrial ones, I will briefly clarify how, in terms of the characterizing technological, ethical and prevention issues, such risks are fundamentally different and cannot be considered as neither comparable nor as equally representative of the category of technological risks.

Following this discussion, the problem of the definition of risk from different disciplinary perspectives is discussed. Some reflections over the relevant conceptual and operational differences in the analysis and characterization of risks are addressed. Here I define some distinctive elements of the risk of major accidents (MA) and I draw some general coordinates along which the analysis of their prevention from a territorial management perspective will be developed. To do so I argue over the differences among some definitions of risk collected in a number of technical glossaries. The comparison focuses on the main variables explicitly considered in the various definitions. By means of this comparison I demonstrate how the consideration of different variables for defining the "risk function" is not just a conceptual exercise: the analytical approaches deriving from different definitions of risk differ, in fact, accordingly.

In conclusion I provide a definitive, though guiding definition of MA risk as I will refer to in the following of the book, stressing the relevance of the concepts of "vulnerability" and the *hic et nunc* dimensions of major accidents risk. By doing so the Chapter wishes to provide the interpretational instruments that will support the reading, in particular, of the following Chapter, where the accidents case-histories relevant to the development of the Seveso Directives are described .

1.1 Risk, Territory and Society: historical background

Urbanization and industry have been the two main coordinates along which European economy has been developing since the consolidation of the industrial society in the early years of the XX century. Since then, the functional reorganization of the space accordingly to the dramatic increase of industrial and densely populated areas has been confronted with the problem of integrating the historical tissue of the European territory with new industrial poles (Menoni 2002)[46]. The *modern city* is indeed the *post-industrial city*, with its new *topos* represented by the *fabric*, the *railway*, the *residence* and the corresponding functions of *producing*, *transporting* and *inhabiting* (Wieczorek 1982)[47].

The modern practice of urban planning was prompted by the necessity of elaborating new policies and instruments "digesting" the industry into European cities while guarantying the efficiency of new vital functionalities, among which those responding to the dramatically augmented residential demand were the most urgent. One aspect of this difficult digestion became rapidly evident: the epidemic threats and insane living conditions resulting from high population density and under-supply of hygienic infrastructures. The embryonic relation between urbanism and industrial city is intimately linked to the discovery that the epidemic diseases and consequent high mortality rates affecting densely populated urban districts, mostly developed as a response to the high workforce demand, was primarily due to the lack of adequate urban infrastructures and safety-oriented regulations (Menoni 2002)[48]. It is hence the initial inefficiency of regulatory instruments in governing the relation among the different *topos* of the industrial city that has led to the development of urbanism as an independent discipline; whose first mandate has been regulating "incompatible" spatial functions and conjugating conflicting land uses (Scandurra 1995)[49].

The conflict between the "new" city and industries was initially resolved with the separation of the relevant locations: "zoning" the city in different areas of homogenous land uses, avoiding the proximity of those conflicting among them while re-qualifying historical centers, was an ordinary urban planning practice in the Europe of the 20th and 21st centuries (Wieczorek 1994). "*To save itself, every great city must rebuild its center*" (Le Corbusier 1924)[50]; and to rebuild their center while allocating space to the new *topos* of the European city, urban planning had to become *functional*. This is the trajectory indicated by the *Charte d'Athenes*, published by the Le Corbusier in 1942[51]. In this fundamental document, the functions of living, working, circulating and

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[46] S. Menoni (2002), Città e Impianti Industriali (English: *Cities and Industrial Areas*), Urbanistica No. 118, INU, Rome.

[47] D. Wieczorek, (1994), *Camillo Sitte et les debuts de l'urbanisme moderne*, Bruxelles 1982. (Italian edition *Camillo Sitte e gli inizi dell'urbanistica moderna*, Jaca Book, Milan, pp. 251.

[48] S. Menoni (2002), *op. cit.*

[49] E. Scandurra (2005), *L'Ambiente dell'Uomo: Verso il Progetto della Citta' Sostenibile (English: The Human Environment: Towards the Project of the Sustainable City)*, Etaslibri, Milano, pp. 291

[50] Reported by P. Hall (1996), *Cities of Tomorrow*, Blackwell Publishers, USA. The centrality of the industry with respect to the intellectual elaborations of the last century is reflected in the works of the then most influential economists, philosophers, sociologists and writers. One significant example is represented by *La cite industriel* of the above mentioned Le Corbusier (1887-1965). His studies over the "minimal living unit" and the linear-city, directly connected to, when not a branch of, industrial areas, stigmatize the conceptual shift from the space as *locus* to the space as *function*. For a comprehensive analysis of the work and thought of Le Corbusier and his contribution to the urban planning discipline, see F. Choay, *Le Corbusier*, George Braziller Inc, 1960, New York.

[51] See Le Corbusier, *Charte d'Athènes*, Paris, Seuil, 1957. The *Charte* was published in a revised form with respect the proceedings of the *Congres International d'Architecture Moderne* (CIAM) of 1933 from which they resulted.

recreating are organized through a planning approach that separates the corresponding land use destinations rigidly. This rationalization of the space was considered functional to avoid that "*nothing is planned for the safeguard of humans*" [52]. In so doing the document promoted the practice of zoning residential, industrial, transportation and recreational areas that will dominate in the course the 21st century.

The process of de-industrialization of European main cities led to the creation of delocalized industrial poles and towns, some of them entirely "created" around new industrial areas and organized in their function[53]. After the Second World War and particularly between the '60's and 70's of the past century, these cities have known a rapid development together with an increased infrastructural and virtual interconnection, to the point that the European territory can be nowadays described as a sort of *continuum* of urban and extra-urban areas forming a poly-centric tissue of extraordinary richness and complexity.

Even if recommended in theory, the practice of separating hazardous industries and population has not been object of a systematic implementation until the "epidemic threat" of accidents revealed its potentials. Fires, explosions and toxic releases occurred all over Europe especially in the second half of the past century, when the development of the chemical and petrol-chemical sectors covered the territory of a capillary net of small, medium-sized and large so-called *hazardous installations*. Some of these catastrophic accidents are still alive in the memory of many, such as the accident in Flixborough (United Kingdom) in 1974 and the accident of Seveso (Italy) in 1976.

Nevertheless, the first records of European major industrial accidents date back to centuries before. The first documented accidents causing, beside their disastrous effects, the re-installation of establishments far away from residential areas, occurred in the XVII century. In 1654 the explosion of a powder tower demolished the city centre in Delft, in The Netherlands. The accident led the municipality to replace the establishment outside the walls of the village. In 1807 a similar accident took place in the nearby Leiden and killed 150 people (Ale 2005)[54]. In response to these events, in 1810 the first regulation stating the necessity of maintaining dangerous industries separated from residential areas was issued by Napoleon[55]. Since more than three centuries, the necessity of a "safe" siting of industries and the precautionary relevance of territorial regulations were, therefore, fully recognized.

However, several evidently controversial industrial poles locations have followed. The evidently problematic location of the petrol-chemical area of Venice for example, located in the

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[52]. A meaningful abstract of the Charte reads "[...] *Parce qu'on a méconnu des règles, des campagnes se sont vidées, les villes se sont remplies au-delà de toute raison, les concentrations industrielles se sont faites au hasard, les logis ouvriers sont devenus des taudis. Rien n'a été prévu pour la sauvegarde de l'homme. Le résultat est catastrophique et il est presque uniforme en tous pays. Il est le fruit amer de cent années de machinisme sans direction* [...] (Translation : *it is because rules were ignored, campaigns emptied, cities filled beyond any reason and the concentration of industries placed randomly that workmen homes became slums. Nothing was planned for the safeguard of humans. The result is catastrophic and it is almost uniform in all countries. This is the bitter fruit of a hundred years of mechanization without direction* […]".

[53] D. Wieczorek, (1994), *op. cit.*

[54] B.J.M Ale (2005), Living with Risk: a Management Question, Reliability Engineering and System Safety, No. 90, pp.196-205

[55] See *Décret impérial du 15 octobre 1810 relatif aux Manufactures et Ateliers qui répandent une odeur insalubre ou incommode*, online. Available at http://aida.ineris.fr/textes/decrets/text2301.htm. Art 1 of the decree establishes 3 categories of plants. The first category is the one which has to be kept "*far away*" from the population; the second the category of fabrics which do not need to be rigorously separated but about which is necessary to acquire the certainty that they will not cause damage to the surrounding properties and population prior to their siting.

first decades of the 21st century at walking distance from the world famous historical city and lying in the middle of the highly sensitive environment of the surrounding lagoon, is an emblematic evidence of the then still scarce consideration of the long-term environmental impacts, and risks, associated to mega industrial poles.

This scarce attention will last until the last quarter of the century, when the occurrence of world-famous disastrous accidents like Seveso and Chernobyl increased the relevance of the theme of *risk* and its counterpart *safety* into the European social and political debates. These events, revealing the augmented disastrous potentials of industrial technologies, led a German sociologist to formulate the paradigm of "risk society". Since the second half of the '80s', the works of Ulrich Beck over the advent of a society "*systematically dealing with risks*" kept becoming academic best-sellers[56]. In his works, Beck does not provide a clear distinction among different kinds of risk, covering them under the common umbrella of *systemic technological risks*[57]. According to this vision, technological risks are a sort of invisible and threatening phantom shaping the economical pattern of the post-industrial society. This phantom does hence indifferently assume the forms of "pollution in foodstuff" or a nuclear facility, remains equally systemic, equally "*not tide to the place of origin*" and causes invariably irreversible and intergenerational consequences[58].

His this paradigm consistent with the case of dangerous industries covered by the Seveso Directives? This is discussed in the following section.

1.2 Re-thinking the paradigm of risk society

In this section I would like to argue more extensively over the paradigm of *risk society* of Ulrich Beck which was introduced before. To do so, I will recall the main pillars the vision of the German sociologist is based on, which are essentially the advent of an industrial era that changed the nature of the risks society is exposed to (natural vs. technological) and the systemic, though unequal, nature and distribution of such risks [59]. According to the German sociologist, contemporary risks are characterized by:

1. unlimited (spatial, temporal or social) impacts;
2. the impossibility of attributing their consequences accordingly to causality, guilt or liability, and
3. the impossibility of compensating their consequences according to pre-existing legal instruments such as the "polluter-pay" principle[60].

First of all I would like to point out that the unbalance and the very distinction between technological and natural risks is less evident than it could have appeared during the 80's, when the work of Beck started to attract the attention of the scientific community. One of the main scientific and political concerns which emerged in the last decades of the XXI century regards, in fact, the phenomenon of climate change. The phenomenon has been related to the global warming induced by the massive emission of greenhouse gases in the atmosphere by means of anthropic activities[61].

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[56] Refer in particular to U. Beck (1992), *Risk Society: Towards a New Modernity*, London, Sage Publication. See also U. Beck (1995), Ecological Politics in the Age of Risks, Cambridge Polity Press; U. Beck (1999), *World Risk Society*, Cambridge Polity Press.

[57] I will provide a detailed definition of systemic technological risk in the following of the Introduction.

[58] Beck (1992), *op. cit.*, at 22.

[59] It is out of the scope of this book to provide a complete review of the work of Beck, of whom only the most relevant assumptions are conclusions are analyzed.

[60] U. Beck (1995), *op. cit*., at 76-77; reported in Arcuri, *op. cit*., p. 2.

[61] There is still a degree of uncertainty concerning the cause-consequence relation determining the phenomenon of climate change, although a general consensus about the trend of increase of global

According to an increasingly established view, effects of climate change are observable in the raising of sea levels and in the increasing frequency of natural disasters such as storms, cyclones and droughts. These catastrophic events appear to be enhanced by human consumption and production patterns, in first place by the global dependency on fossil-fuels for the production of energy (IPCC 2008)[62].

Though presumably enhanced by these technological activities, climate change induced-events such as droughts and storms are *natural* events, which are rather difficult to predict in terms of occurrence and impacts; however, anthropic activities appear to be an important triggering factor. This example is consistent with the increasingly nuanced boundary between *natural* vs. *technological* risks and with the somehow outdated vision of their independency. Technology has an impact on the environment and the latter "responds" adapting its natural course to man-induced developments, the latter consisting also of unwanted consequences on the complexity of the man-environment system (MTE)[63].

Within this system, many kind of risks are not reducible to the strict distinction between natural vs. technological. The consumption of fossil-fuel is, again, an appropriate example: what earth employed thousands of years to accumulate underground has been accessed and converted into energy during the last few human generations by means of increasingly efficient technologies. The conversion of such resources into energy keeps giving back to the atmosphere an amount of greenhouse gases which cannot be digested, at natural rhythm, without the current state of accumulation and consequent warming effects. Clearly, man changed the "natural course of events" by means of design and operation of technologies aimed at responding to his necessities, provoking in so doing also unwanted consequences. Among them, climate change and induced natural disasters are the most concrete, and it is somehow difficult (and maybe unnecessary) to draw a line between their "technological" or "natural" nature.

Whilst the phenomenon of climate change is an example of natural events triggered by human activities, the so-called *natural-technological* (na-tech) events are an example of technological phenomena triggered by natural events. An example is provided by the study of Steinberg and Cruz (2004) over the technological accidents provoked by the August 17, 1999 earthquake in Turkey. More than 21 accidents following the natural catastrophe were documented, with more than 8 of these events resulting in off-site impacts to the surrounding communities[64] .

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temperature and the influence of anthropic activities on it has been reached within the international scientific community (refer to the literature provided by the Intergovernmental Panel on Climate Change, online. Available at www.ippc.ch. Last visited: June 2008). For the possible relation between climate change and land use planning in a risk prevention perspective, refer to P. Schmidt-Thomé (2006), *Integration of Natural Hazards, Risks and Climate Change into Spatial Planning Practices*, PhD Thesis No.193, Faculty of Geology, University of Helsinki.

[62] Refer to IPCC (2008), C*limate Change 2007: Synthesis Report,* Sweden, online. Available at http://www.ipcc.ch/ipccreports/ar4-syr.htm . Last visited: June 2008

[63] The systemic interdependency among natural, human and hence technological systems is acknowledged, among others, by B.J.M Ale, in particular when he recall the vision of Kulhlman in which the scholar alleges that "[…] *Industrial, technological and natural risks should be studied and controlled in the system consisting of Man, Technology and Environment. In this system man designs and operates technology, influences and changes his environment and at the same time is affected by the technology he designs and operates and by the environment that he changed* […]". Refer to B.J.M Ale (2007), *Risk for Beginners*, Delft University of Technology, at 29

[64] L. J. Steinberg and A. M. Cruz (2004). When Natural and Technological Disasters Collide: Lessons from the Turkey Earthquake of August 1999, *etc*. The interaction between *natural* and *technological* disasters has led to the development of a research field focusing on so-called na-tech risks (Cruz 2003; Cruz *et al* 2006; Vetere-Arellano *et al* 2004). As an emerging risk which originates from the interdependency of systems

This kind of events demonstrates how "[…] *simultaneously, response efforts are likely to be required to attend to the technological disaster as well as the triggering natural disaster*"[65]. In the light of this remark, a strict distinction between natural vs. technological in the definition of such phenomena appears restrictive: though the general distinction between risks posed *by technolog*y and risks posed *by nature* has to be accepted in principle, it is important to not isolate the relative systems and to consider how their interaction will determine their immediate as well as long-term consequences

At this point, I will argue on the paradigm of risk society from a different perspective. Accepting Beck's less nuanced distinction among technological, natural and societal risks[66], I would recall his characterization of the first as the risk of *irreversible*, *time and space unlimited consequences* of ultra-hazardous technologies. The consequences of industrial accidents, when related to the death of humans and/or loss of environmental patrimony, are indeed irreversible. On the other hand, one of the descriptive coordinates of a major accident, however severe and catastrophic, is its *geographical area of impact.* Though the preciseness of its *ex-ante* estimation is part of the inherent unpredictability of this kind of events, this "ray of impact" is necessarily limited: accidents occur in a given *hic et nunc* which is fundamentally different from the *non-site specific* and *continuous* development characterizing the consequences of other types of events, such as the transmission of the BSE disease in the food-chain or the worldwide diffusion of a pandemic flu.

The view of Beck seems to be not in line with this assumption:

> "[…] *Nevertheless, the ecological and high-tech risks that have upset the public for some years now (...) have a new quality. In the afflictions they produce they are no longer tied to their place of origins – the industrial plant. By their nature they endanger all forms of life on this planet. The normative basis of their calculation – the concept of accident and insurance, medical precautions, and so on – do not fit the basic dimension of these modern threats. Atomic plants for example are not privately insured or insurable. Atomic accidents are accidents no more (in the limited sense of the word "accident"). They outlast generations. The affected even include those not yet alive at the time or in the place where the accident occurred but born years later and long distance away*. […]"[67]

According to this abstract, the *hic et nunc* dimensions of accidents are neglected in favour of a non-site specific and continuous characterization of their consequences: *accidents are accidents no more*. Applying this vision to industrial risks, the precautionary relevance of the opportune siting of hazardous plants is practically null: if the *distance* between hazards and

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(Cruz *et al* 2004), the literature relies on limited historical data. According to Cruz *et al*, the role of planning (both ordinary and emergency planning) in this domain is crucial, as the consideration of the interaction between natural and technological systems when allocating land use destinations can prevent the catastrophic development of a triggering natural event into one or more technological disasters.

[65] Steinberg, L. J. and A. M. Cruz (2004), *op. cit*.; reported in L. Steinberg *et al* (2004), *State of Art in Natech Risk Management*, Joint Research Centre Technical Report EUR 21292 EN, at 2.

[66] Regarding the social risks society is less exposed to than in the past, Beck mentions the risk of war. Here the vision of Beck reveals to be rather Western-centric and to refer to advanced economical and technological contexts, most probably the European and Northern American contexts. In African and Asian countries in fact war is still a major form of social threat.

[67] Beck (1992), *op. cit.*, at 22.

vulnerable targets is not a preventive measure, the room for prevention is restricted to minimizing the probability of occurrence of events, or rather to the elimination of hazards *tout court*. Some reflections over the consistency of this vision with all kind of *industrial plants* mentioned in the abstract appear hence necessary.

Technological risk results from the interaction between technology and humans (Ale 2007). In the case of industrial accidents, the interaction regards both the workers operating the technology and third-parties, i.e. the subjects exposed to the risk without having a direct relation with the technology posing it. In the case of industrial risks, these interactions are site-specific: they "happen" in a given part of the overall MTE system, which could be defined as the specific man-plant interaction.

When Beck alleges that the affliction of accidents is *no more tied to their place of origins*, his focus is on the overall MTE system: that is to say, accidents can be *everywhere*. Furthermore, his analysis explicitly refers to those kinds of event whose impacts are intergenerational[68]. In the final part of the reported abstract he makes indeed the example of atomic accidents; which are fully consistent with this description. My question here is: is it possible to extend the example of atomic accidents to all kind of industrial accidents? More specifically: are atomic accidents and chemical accidents involving dangerous substances (as a fire provoked by a leakage of LPG or a release of chlorine) belonging to the same category of "industrial accidents" and are they, consequently, interchangeable in terms of the phenomenon they represent?

To answer this question I will first of all point out that the design and operation of nuclear facilities, differently than chemical facilities, is not permitted in all the Western countries the analysis of Beck identifies under the common umbrella of "society". Sweden in 1980, Italy in 1988, Belgium in 1999 and Germany in 2000 have initiated the route towards the gradual decommissioning of nuclear power plants, with the radical position of Italy which decommissioned existing facilities before the conclusion of their life cycle[69]. The debate on the desirability of nuclear technology is lively also in countries with long established nuclear infrastructures: in The Netherlands, one of the outcomes of the investigation "*Broad Social Discussion on Nuclear Energy*" conducted in the 80's outlined how the risks arising from nuclear facilities were not broadly accepted by the population as they were deemed too high[70].

Nuclear power plants are well known for the long-term effects of potential accidents and for their catastrophic consequences, indeed of intergenerational relevance. Furthermore, they pose the problem of the disposal of nuclear wastes, which is again a risk to which complex ethical and precautionary issues are associated. Though a minimal percentage of the uranium oxide which is used to fuel reactors results in long-term radioactive waste, current technology has to provide solutions for their storage up to 10000 years (Ale 2007). Even though it could be argued that a number of other chemical substances have long-term consequences, affecting those not born yet[71],

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[68] In order to avoid confusion, I wish to clarify that in the chapter of the work of Beck from which the abstract is taken ("*Living on the Volcano of Civilization"*), the Author interchangeably refers to the following risks: distribution of pollutants, toxins, contamination of water, air and foodstuff and, in the reported abstract, industrial accidents, which representative example is that of nuclear accidents.

[69] IAEA, *50 Years of Nuclear Energy*, online. Available at: http://www.iaea.org/About/Policy/GC/GC48/Documents/gc48inf-4_ftn3.pdf . Last visited: March 2008.

[70] Refer to H. Zandvoort (2005), proceedings of the congress *Emergency & Risk Zoning around Nuclear Power Plants*. C. Kirchsteiger, J. Kubanyi and A.L. Vetere Arellano (eds.), Joint Research Centre of the European Commission, Institute for Energy, The Netherlands.

[71] Many examples are possible. One that will be mentioned in the course of the book is dioxin, whose emission after the accident of Seveso in 1976 led to the preventive abortions among the population. The long-term effects of dioxins are also documented by the pre-natal deformations and late cancers which affected the Vietnamese population until recent years, due to the massive usage of the "Agent Orange" by the

radioactive radiations have the specific characteristic that once their emission occur, their consequences on the surrounding human and natural environment are not confinable into a limited time-space horizon. Although the process industry and the nuclear industry have much in common in terms of the management of the plant and the hazard, "*the nuclear industry has unique features*" (Lees 1996): whereas the intergenerational consequences of chemical accidents depend on the substances involved and on the evolution of events, whose developments are in most cases promptly confinable within the immediate surroundings of the plant, in the case of radioactive emissions they are a certainty and a primary characterizing element. Finally, an important aspect of nuclear accidents prevention can be reassumed with the expression "*uncertainties are very great, experience is very limited*" (IAEA 2005): there are no many historical data on major nuclear accidents, and the awareness of the short-term, mid-term and long-term consequences of radiations on humans and the environment are based on a still poorly documented knowledge[72]. Last but not least, next to a diffuse social aversion for nuclear technology, the worldwide political concerns over nuclear proliferation have to be considered: nowadays we are assisting to the hard battle to limit the development of nuclear technologies in countries whose geo-political situation is considered a possible pre-condition for their utilization for war purposes.

Keeping the focus on the industrial applications of nuclear technologies, the certainty of the irreversible consequences following the release of radiations and the intergenerational duration of their effects on humans, it is possible to conclude that the debate around the desirability of nuclear technology and the acceptance of associated risks is rather different than in the case of chemicals: whereas chemical facilities are in fact mainly object of a debate regarding their siting, nuclear facilities are primarily object of a debate regarding their very desirability. In other words, whereas in the first case the matter of *risk acceptability* regards mostly the *how*, in the second case it primarily regards the *if*. In many countries, such debates concluded with the choice of decommissioning nuclear facilities and the implicit declaration that associated risks are *unacceptable*[73].

In the light of these arguments, it can be concluded that nuclear risk is not representative of the general category of "technological risks" as done by Beck in his work[74]. Fig 1 and 2 intend to

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side of Americans. Similar consequences followed the accidents in Bhopal in 1984, involving a toxic release of methyl-isocyanate, and late health effects were observed also among workers exposed to inhalation during the processing of PVC in the 70's of the past century.

[72] An extensive analysis of the most relevant nuclear accidents of the last decades, among which Three Mile Island and Chernobyl, is given in F. Lees (1996), *Loss Prevention in the Process Industries -Vol. 3*, Butterworth-Heinemann.

[73] It is important to point out that decommissioning nuclear facilities in one country doesn't exclude the risk of facing the consequences of nuclear accidents, being such consequences easily transnational. A second interesting point of reflection is represented by the current debate over the re-installation of nuclear facilities also in countries which have implemented a non-nuclear energy policy. This debate arises from the current concerns related to climate change and the post-Kyoto agreements on CO_2 emissions reduction. The first point confirms the more unlike site-specificity of the consequences of nuclear accidents, whereas the second may be a good point of departure for analyzing the matter of the risk/benefits balance society is periodically called to debate depending on the different prioritization of safety objectives and economical standards.

[74] This conclusion is in line with the conclusions of C. Kirchsteiger (1999) when he alleges: "[...] *mainly due to the significantly different perception of the risk related to different type of events by different observers (e.g. transport accidents vs. nuclear accidents) there is no single definition of "accident" and not even of a "major accident". Such definitions are usually based on various types of adverse consequences (...) and qualitative and quantitative threshold levels for each type of consequence descriptor, and are usually applicable only within an accident category, e.g. within "industrial accidents" but not within "industrial accidents" and "nuclear accidents"* (emphasis added) […]. Refer to C. Kirchsteiger (1999), Trends in

summarize this conclusion. The first represents the classification of systemic technological risk which can be derived from the vision of Beck. The second re-classifies risks in terms of the distinction between nuclear and non-nuclear risks and highlights the attributes of "intergenerational" and "irreversible" of the associated consequences.

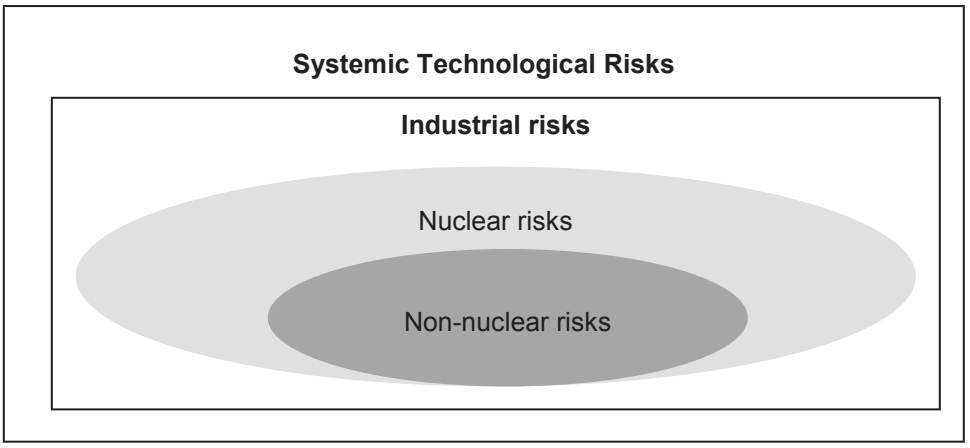

Fig 1 – a classification of industrial risks according to the vision of Beck.

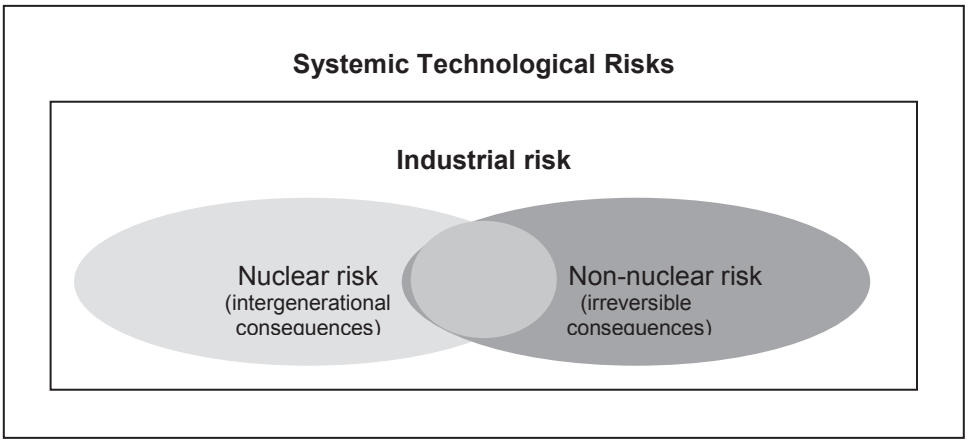

Fig 2 – a re-classification of industrial risks according to the distinction between nuclear and non-nuclear risks

The intersection between the category of nuclear and non-nuclear risks represented in Fig 2 represents the "fuzzy area" they share with regard, in particular, to the possible intergenerational consequences which can be associated to the relevant accidental events. However, whereas this factor represents a characterizing element of nuclear risk along the whole technological life-cycle (from energy production to waste disposal), in the case of non-nuclear accidents this characterization depends on the substance involved and on the specific development of accidental events. This is the reason why I would conclude that the two categories of events should not be considered as equally representative of the phenomenon of "industrial risks" and they should be analyzed, and discussed, separately.

Accidents, Disasters and Risk Sources in Europe, Journal of Loss Prevention in the Process Industry, No.12, 7-17

A second important element of the paradigm of risk society is strictly related to this distinction between nuclear and non-nuclear accidents. In Beck's view, the evolution up to the current "risky" technological pattern is due to the catastrophic, yet invisible threat posed by ultra-hazardous technologies, among which he doesn't distinguish nuclear, chemical, polluting substances, etc. His vision identifies "new technologies" and "risks" as the two faces of the same coin, no matter the technology of concern and the benefits and balance with other risks these technologies produce.

At this point, it may be helpful to recall the definition of technology as "*the application of scientific knowledge to the practical aims of human life or, as it is sometimes phrased, to the change and manipulation of the human environment*"[75]. According to this general definition, every single manipulation of the human environment along history has to be considered *technological*. The first iron tool, the construction of the first transoceanic wood ship, the discovery of the fire dust up to the first vapour engine, are fully *technological*.

Were these technological developments risk-free?

Certainly not; rather, the relative societal contexts were less depending on them and were not directly exposed to their consequences in large majority. Indeed other forms of natural and social threats which can be nowadays differently governed by society were shaping the organization of the pre-industrial one. As argued by Ale: […] "*many ancient risks have had a similar standing in the society in which they were dominant. They formed a threat to the whole – known – world, and all – known – societies were exposed* (…). *Also what is now called industrial risk has roots in the early centuries* […][76]. In this perspective, the pathway started with the first systematic production of goods up to the modern industrial era created new risks while replacing others, in so doing augmenting the life expectancy of the countries which walked along this route (Ale 2007; Leiss 2001). Furthermore, the concept of risk itself was formalized for the first time only in the XVII century and any application of it with regard to the estimation of "other face of the coin" of technological developments remained, until the XIX one, an intellectual exercise of no direct application to risk prevention and policy making[77]. This doesn't obviously imply that risks

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[75] *Technology* (2008), Encyclopedia Britannica. Online. Last Visited: March 2008.

[76] B.J.M Ale (2007), *op. cit*., at 9

[77] The modern "mathematic of chance" is usually dated back to a correspondence between the French mathematician Pierre de Fermat and Blaise Pascal in 1654. The first in particular, in front of the resolution of a problem related to the games of chance, resolved the matter in terms of *chances* or *probability*. In the XVII century, Pascal's strategy for solving problems of chance became the standard one. The first applications of the calculation of probabilities were tied up with the questions of law, in particular with regard to the issue of "fair contract"; but it is only in 1670, precisely in The Netherlands, that probability began to be used to determine, among other issues, the proper rates at which to sell annuities. Other applications of probabilities were developed in the United Kingdom in the sphere of religious or ethical judgments, particularly thanks to the work of Joseph Butler of 1736 wherein probability is defined as "*the very guide of life*". The shift from the use of probability as an answer to skepticism towards the recognition of probability as a tool to elaborate information and statistics occurred, however, not before the XVIII century and it was fully achieved only in the XIX, when Pierre de la Place called probability "*good sense reduced to calculation*". Until this systematic practical application, the concept of probability had been informed by some kind of moral value or, better, it expressed a way of rational reasoning opposed to the predominant, and merely fatalist, irrational one. A more instrumental use of the concept, especially for performing statistical calculation, was developed between the XVIII and the XIX centuries, when colonial nations started to cense their population together with that of their colonies and, parallel to this, started to elaborate data over the mortality and birth rates of their nations accordingly to age and gender (refer to *Probability and Statistics* (2008), Encyclopedia Britannica. Online. Last visited: March 2008). It is however thanks to the development of economy and econometric in particular that the application of probabilistic calculation acquired the current sense of

were not existing: as also Beck argues at a certain point, also Columbus departing for the discovery of new world took a risk or, to refer to a more consistent example, also the status of the Thames in the London of the XIX century was a clear risk for Londoners; people falling into it chocked because of the inhalation of the poisoning fumes smoking from its surface[78].

Keeping the focus on this example, Beck argues that the fundamental differences between it and the current risks are essentially two: the sensible nature of threats (*visible*, *tangible* and *breathable*) and their derivation from an undersupply of hygienic technology. Nowadays risks are, instead, *invisible*, *intangible* and *systemic* – they indifferently regard human, animals and plants and they have what Beck calls *modern causes*. Accepting this view in principle, it is important to not arrive to the misleading conclusion that technological risks are the "youngest son" of modernization and that before the second industrial revolution or, accordingly to Beck's view, the Second World War, they were unknown phenomena.

As mentioned before the siting of hazardous industries started to be object of regulation in the XVIII century, when the first decree requiring to separate industries and population was issued by Napoleon. Certainly, these measures were not formalized accordingly to the current conceptual instruments; in the Napoleon decree for example, for the second category of (potentially dangerous) establishments the *certitude* (certainty) that *les opérations qu'on y pratique sont exécutées* will not cause damages to the surrounding population has to be acquired prior to their siting. The decree does hence require the acquisition of *certainty* rather than the estimation of risks. However, their *invisible* dangerousness was fully recognized.

In conclusion, dangerous industrial activities have been operating since more than three centuries; rather than from *modern causes*, their *increased dangerousness* derives from the developments industrial technologies have been subject to, both in quantitative and qualitative terms. Quantitatively, dangerous industries have surely grown in size and number, augmenting their interaction with the surrounding contexts and their influence on their spatial and functional organization. Qualitatively, new substances and processes replaced old ones, and new forms of threats have been surely created. On the other hand, dating the "risk society" back to these developments should not be interpreted as the threshold between a "non-risky" and a "risky" technological pattern.

In the light of these general arguments, some conclusions can be derived:

1. the need of a more nuanced distinction between technological vs. natural risks;
2. the need of distinguishing the characterizing features of nuclear, non-nuclear and other forms of industrial risks;
3. the need of distinguishing *irreversible* and *intergenerational* consequences.

These points conclude the analysis of the work of Beck relevant to this study. Considering that the purpose of the German sociologist is making the "phantom of risk" visible to its audience,, and acknowledging the sure relevance of his analysis to current technological and societal patterns, his theory remains the starting point of every study willing to shed light on the challenges associated to the concept and matter of risk in our society. However, some of the forms the phantom assumes are as old as human history, some others were born with modernity and some others are surely not born yet; what counts is avoiding misleading generalizations and framing the discussion over their *desirability* and/or *acceptability* within the proper context.

To do so, planners and policy makers need to acquire a number of new interpretational instruments. These are introduced in the following.

"calculation of uncertainty", i.e. *risk*. An interesting reading on the historical evolution of this concept is in P.L. Bernstein (1996), *Against The Gods: The Remarkable Story of Risk*, USA, John Wiley & Sons.

[78] U. Beck (1992), *op. cit*., at 21.

1.3 Risk and its counterparts: a terminology battlefield?

The contributions of planners to the matter of major accidents prevention has been less represented in literature in comparison to those provided by risk analysts and, generally, risk experts. Several original contributions have also been provided by social scientists, particularly scholars of law and sociology.

Arcuri in particular analyzes the problem of regulating catastrophic risks prevention from a Law & Economics perspective[79]. The theoretical background of her analysis is represented by the corner-stone of sociological studies on risk: the academic best-seller *Risk Society* of Ulrich Beck which was analyzed before. Arcuri does therefore move from a sociological towards a legal analysis and the inadequacy of legal systems to cope with the emerging "risk society" is the starting point of her work[80].

Leaving her further developments aside[81] I would like to quote the definition of risk and its counterparts reported in her work. Arcuri recalls the classical Knightian definition of risk as the *measurable uncertainty*, i.e. the uncertainty which can be object of probabilistic calculation[82]; she then derives four different definitions, summarized in Table 1:

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[79] A. Arcuri (2005), *op. cit.*

[80] With regard to the inadequacy of legal systems to cope with ever-known disasters, I would like to refer again to a non-scientific contribution. In the world famous report the German philosopher Hanna Harendt wrote in 1961 over the process against Adolf Eichemann, hold in front of the court of Israel after his kidnapping from Buenos Aires by the side of Israeli secret agents , the then journalist of the *New Yorker* argued over the inadequacy of two juridical elements: the legal principles the court could refer to for judging the ever known crime of the deportation of millions of Jewish and minority groups, of which the German hierarch was judged the main responsible; and the inadequacy of a court with national jurisdiction in front of a crime perpetrated against humanity. The two "legal gaps" were only apparently filled by the process of Nierenberg. One of the conclusions of the philosopher in front of the development and outcomes of the process was the necessity of instituting a *permanent international court* which could have proceeded against these kind of crimes in an internationally-agreed legal context (refer to H. Harendt, *Eichemann in Jerusalem*, 1963:64, published by arrangement with Viking Penguin, Penguin Putnam Dnc. The edition in my possession is the Italian H. Harendt (2006), *La Banalità' del Male*, Saggi Feltrinelli). 37 Years later, the International Criminal Court of The Hague was established by means of the agreement of 120 nations and it is nowadays the legal institution where war criminals of the same carat of German hierarchs are judged. Keeping this as an example of *a lesson learned from an historical disaster* the increasing number of international agreements over the environmental policies to be globally adopted to protect our planet from the consequences of pollution and degradation could appear under a similar light. The Rio conference of 1992 and the Kyoto Protocol are examples of transnational agreements meant to overcome the limits posed by single national jurisdictions and actions. Interestingly, one of the proposed development of these agreements is the institution of a International Tribunal for the Environment (refer among others to A. Rest, 2000, The Role of an International Court on the Environment, Working Paper for the Conference "*Giornata Ambiente 2000*", Rome).

[81] The core of the analysis of Arcuri is the detailed verification of the validity and applicability of selected legal tools, namely the precautionary principle, the liability principle and a set of safety-related laws among which the Seveso Directives. The analysis of Arcuri intends to derive recommendation for a multi-dimensional understanding of the "risk law" and it is hence not limited to a mere review of contemporary legal instruments. The economical trade-offs associated with risks on the one hand and the psychometric perspectives for their characterization on the other are also accounted in her conclusions. The latter are represented by a general framework for risk policy-making process.

[82] F. H. Knight (1921), Risk*, Uncertainty and Profit, Houghton Muffin Company*, New York. Reported by A. Arcuri, *op. cit*., at 23. The classical examples reported by the Italian scholar are that of throwing a dice and getting a six (*measurable uncertainty*) against the probability of a particular building burning down on a particular day (*uncertainty*). In the context of major accidents risk, the example could be rewritten as the

Table 1 – Risk and its counterparts (after Arcuri 2005)

Certainty	Knowledge about certain outcome
Risk	Knowledge about probability and outcome
Uncertainty	Knowledge about outcome; ignorance about probability
Ignorance	(Ignorance) About outcomes and probability

The four definitions, though acceptable in principle, have been object of further elaborations from Knight onwards[83]. In particular, the distinction among different kinds of risk accordingly to the risk source, and the different degrees of uncertainty over the expected probabilities, effects and consequences, have been object of a conspicuous number of studies.

The developments more relevant to this study are the before mentioned distinctions between systemic and site-specific risks[84] and between "simple risks" and risks with a predominant uncertain character[85].

For a definition of systemic risks I referred, among others, to the work of Klinke and Renn[86] and to the fundamental *White Paper on Risk Governance*[87] issued by the International Risk Governance Council. The definition of systemic risks given in the White Paper reads as follow:

> "*Those risks which affect the systems on which society depends – health, transport, energy, telecommunication etc. Systemic risks are at the crossroads between natural events (partially altered and amplified by human action such as the*

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probability of one accident scenario among a pre-defined set of scenarios and the day the accident will happen.

[83] It has to be stressed that in economical jargon the outcomes the evaluation of risk refers to are not assessed against a value judgment, i.e they are neither positive nor negative. In environmental risk assessment, epidemiology and other disciplinary domains, outcomes have usually a negative connotation (damages, losses or injuries). In this book, when referring to the outcomes or consequences of major accidents, I will always refer to this second connotation unless differently specified.

[84] The definition of site-specific risk in the context of land use planning and MA is suggested among others by S. Menoni (2005), *Costruire la Prevenzione* (English: *Building Prevention*), Pitagora Editrice, Bologna. Generally, for site-specific risk I intend those risks posed by a source having a recognizable geographical collocation (see K. Hewitt, 1997, *Regions of Risk*, Addison Wesley Longman Limited, Essex). In this perspective, also the risk posed by nuclear power plants, electromagnetic fields and nuclear waste disposals can be regarded as site-specific. This doesn't deny their "global dimension": refer to A. Amendola (2002), *Gestione dei Rischi: dai Rischi Locali a quelli Globali* (English: *Managament of Risks: from Local to Global Risks*), Quaderni CRALS, No.2.

[85] This distinction should not to be confused with the economical distinction between risk and uncertainty reported at the beginning of the Introduction, but should be regarded as the "fuzzy area" comprised between the two. An overview of the various meanings and policy implications of the two terms for risk prevention and management is A. Amendola (2004), Management of Change, Disaster Risk, and Uncertainty: an Overview, Journal of Natural Disaster Science, Vol.26, pp55-61

[86] A. Klinke and O. Renn (2006), Systemic Risks as Challenge for Policy Making in Risk Governance, Forum Qualitative Social Research, Vol. 7, No.1, Art.33. Online: http://www.qualitative-research.net/fgs/.

[87] O. Renn and B. Graham (2005), *White Paper on Risk Governance*, International Council on Risk Governance (eds.), Geneva, pp. 156

emission of greenhouse gasses), economic, social technological developments and policy-driven actions, both at the domestic and the international level[88]".

As introduced in the previous section, a first question is: are major accident risks eligible to the attribute of *systemic*? Concerning the second point, the definition of *uncertainty* reads as follow:

"*A state of knowledge in which, although the factors influencing the issues are identified, the likelihood of any adverse effect or the effects themselves cannot be precisely described. (Note: this is different from ignorance about the effects or their likelihood*. […]"[89].

A second question here is: are major accidents more "uncertain" than others?

The first question was analysed in the previous section by referring to the works of Beck. The definition of *uncertainty* as given by Renn helps to reply to the second[90]. The inherent uncertainty of the analytical process aimed at quantifying the probability and assessing the magnitude of industrial accidents is since long acknowledged in literature[91]. The significant influence of experts' judgments on the estimations and characterizations of risks is demonstrated in a number of benchmark studies[92]. Though the cause-consequence relation among the

[88] O. Renn (2005), *op. cit*., at 21.

[89] *Ibid*

[90] The economical definition of uncertainty was given before. In the ordinary language, *uncertain* refers to something "we don't know something about". This variety of definitions, together with the connotations of the informal language, is responsible of a proper "terminology battlefield" among the two often opposite sides of applied and social scientists and the public called to take part to the debate on risk. To resolve this controversy it might be useful to refer to the concept of *unpredictability*. The *mathematical certainty* informing the probabilistic calculation of the chain of cause-consequence relations linking a technological failure with a final accident doesn't in fact exclude the *unpredictability* of the resulting scenarios. The latter strongly depend on contour-conditions (which could be reassumed as the mentioned *hic et nunc* conditions) and the variables considered for accidents modeling purposes. This consideration does not intend to re-dimension the role of accident modeling, but rather setting the limitations of its applicability. This remark finds support in one work of Stirling, wherein the Author alleges […] *The strict sense of the term uncertainty (...) applies to a condition under which there is confidence in the completeness of the defined set of outcomes, but where it is acknowledged to exist no valid theoretical or empirical basis confidently to assign probabilities to these outcomes (...). Both risk and uncertainty, in the strict sense of these terms, require that the different possible outcomes are clearly characterizable and subject to measurement. The discussion* (…) *has already made clear that it is often not the case – the complexity and scope of the different forms of environmental risk and the different ways of framing and prioritizing these can all too easily render ambiguous the definitive characterization of outcomes* […] (refer to A. Strirling and S. Mayer (2000), Precautionary Approaches to the Appraisal of Risk: A Case Study of Genetically Modified Crop, International Journal of Occupational and Environmental Health, V.6, No. 4, pp. 296-311).

[91] Refer among others to A. Amendola, *Integrated Risk Management: Recent Paradigms and Selected Topics, Integrated Management for Disaster Risk*, Research Booklet No. 2, Disaster Prevention Research Institute, Kyoto University, at 3. As the Author clarifies in this booklet, the inherent uncertainty in the estimation of risks and the variability of the risk analysis results […] *should not be understood as a criticism to the attempts of quantifying the risk. Indeed quantification of risk is a legitimate scientific approach to deal with (or to reduce) the uncertainties in the occurrence of certain undesired events and outcomes. However it should let us reflect for avoiding simplified generalization and moving towards the development of more consistent and retrievable procedures* […]. A. Amendola, *op. cit*., at 4

[92] See K. Lauridsen *et al* (2002), *Assessment of uncertainties in risk analysis of chemical establishments. The ASSURANCE project. Final summary report*. Risø-R-1344(EN)

interconnected elements of an accident can be modelled (i.e. is *known*), the calculation of its likelihood and, above all, the assessment of the adverse effects on the surrounding environment cannot be *precisely* obtained. Here, the term *precisely* is voluntarily emphasized: it is in fact the lack of *preciseness* in describing the consequences of accidents that constitutes the area of uncertainty the definition of Renn seems to capture. *Unpredictability* and *impreciseness* may be therefore regarded as the underlying concepts of *uncertainty* in the context of major accidents modelling[93].

At this point it is reasonable to question whether the risk of major accidents is fully represented by any of the definition reported in Table 1. As I will discuss in the conclusions of this Chapter, the reply depends on the dimensions which are considered to characterize it. In a mono-dimensional perspective, where risk is calculated by means of the "essence of risk" concept R = P * C and the consequences C are expressed, for instance, as the individual risk of dying due to the exposure to a given hazard, we may conclude that the risk of major accident is fully consistent with the definition of risk provided in Table 1. In a multi-dimensional perspective instead, in which the fan of the considered consequences are both local, immediate and tangible consequences and cross-border, long-term and intangible ones, the given definition of risk may be reductive.

This point is more important than it may appear at first glance. The opposition between different perspectives on risk, like the engineering-dominated and the psychometric perspectives, may be related to the definition of risk as a mono vs. multi-dimensional concept (Arcuri 2005, H-Jones 1998)[94]. A recent European project named Risk Bridge investigated the different "meanings and contextualization" of risk and provided an overview of what is meaningfully defined as the corresponding "terminology battlefield". This is discussed in the following section.

1.4 Some guiding definitions

In one of the Working Papers of the Risk Bridge project some definitions of risk as reported by different glossaries are listed, namely[95]:

a) combination of frequency, or probability of occurrence and consequence of a specified hazardous event[96];

b) expected losses (of lives, persons injured, property damaged and economic activities disrupted) due to a particular hazard for a given areas and reference period. Based on mathematical calculation, risk is the product of hazard and vulnerability[97];

c) the uncertainty of outcome, whether positive opportunity or negative threat, of actions and events. It is the combination of likelihood and impact, including perceived importance;

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[93] One interesting Annex of the White Paper for Risk Governance (Annex C, at 147) is the inventory of the different terminology adopted in a number of glossaries and guidance issued by a number of European and extra-European Organizations. The reading of the inventory brings to light the sometimes remarkable difference in the definitions of key-concepts such as risk, uncertainty, hazards etc. as adopted in different countries, risk regulations, or different regulatory fields within the same country. The compilation of inventories in order to demonstrate the non univocal definition of a number of ordinarily used concepts is not new in literature. In one relatively outdated work of C. Vlek, 11 definitions of risk are inventoried (Vlek 1996).

[94] T. Horlick-Jones (1998), Meaning and Contextualization in Risk Assessment, Reliability Engineering and System Safety, V.59, 79-89

[95] C. Basta *et al* (2007), *op. cit.*

[96] L. Fabbri (2000), *op. cit*.

[97] European Environmental Protection Agency Glossary (2007), *Risk*, online. Available at http://eea.europea.eu/glossary . Last visited: March 2008

d) an uncertain consequence of an event or an activity with respect to something humans value. Such consequences can be positive or negative, depending on the values that people associate with them[98].

The concept of *probability* and *consequence* are explicitly or implicitly mentioned in all four definitions. All of them reflect, in so doing, the definition of risk as the combination of probability and effects, without necessarily associating to the latter a positive or negative connotation.

However, by looking at the progression from the first to the fourth definition it is evident that other elements are added. The first one, taken from a technical glossary, replicates the classical definition of risk as "chance time consequences" of an hazardous event; the second one, provided by the European Environmental Agency, specifies the consequences of concern and extrapolates from the "equation" of risk the variable of *vulnerability*. The third and the fourth definitions define consequences more qualitatively, underline the component of uncertainty and stress the relevance of their perceptions by the side of humans; in particular, the fourth mention the relevance of what humans *value*. In simple words, the last two definitions relate the positive vs. negative attribute of consequences to human values and perceptions.

By looking at the variables mentioned in the first two definitions, it is possible to derive some interesting remarks. To do so, I derived from each of them a simple formalization. From the definition of the EWGLUP Glossary, it is possible to derive the following one:

$$R = f(P * C),$$
$$\text{Where } P = \text{probability}$$
$$C = \text{consequences}. \qquad (1)$$

The second one, adopted by the EEA, can be reassumed as in the following:

$$R = f(H * V),$$
$$\text{Where } H = \text{hazard}$$
$$V = \text{vulnerability}. \qquad (2)$$

Considering that both definitions are referring to the consequences of risks as negative, and are adopted within the same disciplinary context of technological and natural risk prevention, their difference is worthy of some considerations. While the first formalization "isolates" the risk to the event, considering the reaction of the involved context implicit to the concept of *consequences*, the second definition extrapolates the element of vulnerability explicitly: the vulnerability is an independent variable.

This difference is not banal and has been object of discussion in literature[99]. As argued by Menoni in her work over the "construction of prevention"[100], accounting the variable *vulnerability* as one of the independent dimensions of risk lead to operational beside formal differences. This difference is explained as in the following: "[…] *it is necessary to make a distinction between "sensitivity to" and "expectancy of" damage (...). The expected damage is the product of a hazardous agent on a given vulnerable system; the vulnerability is an attribution of the latter, an own intrinsic characteristic* […]"[101].

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[98] In O. Renn and P. Graham (2005), *op. cit*.
[99] S. Menoni (2005), *op. cit*.
[100] *Ibid*
[101] S. Menoni (2005), *op. cit*., at 49.

As acknowledged by the same Author, the use of the term *independent* is controversial and, in order to avoid misunderstandings, shall be clarified. In general a target (human or environmental) cannot be assessed in terms of its vulnerability if not in relation to a hazard, i.e. it is vulnerable *to something*. On the other hand, there are an *intrinsic* and an *extrinsic* form of vulnerability: the first is independent from positional considerations, whereas the second is related to the vicinity to the hazard. Both forms of vulnerability are relevant to the case of major accidents risk, and are hence relevant to the land use planning evaluations to be performed in the surroundings of hazardous installations[102].

Before developing the discussion in this direction, it is important to stress the main conclusion of this overall reasoning: The variables which are considered for characterizing risks have a repercussion on the way relevant analyses will be performed. In this perspective, defining risk in a univocally applicable way is not the important issue; providing a definition of risk that leads to perform the proper evaluation, surely is. In the light of these considerations, two general conclusions can be derived, namely

1. risk is a multi-dimensional concept of no univocal definition, and
2. *a* definition of risk shall reflect the variables and dimensions relevant to the scope of its evaluation.

In the light of these conclusions, a definition of risk in the context major accidents and land use planning is given:

> *Risk represents the possibility of losses or disruption of lives, goods and options humans value*.

Such losses or disruptions regard a given human-environmental system, refer to one or more hazardous events caused by one or more interconnected elements of the system, and may be irreversible. Their possibility derives from the interaction of four elements: the nature and likelihood of the hazardous events and the intrinsic and extrinsic vulnerabilities of the system.

Having clarified so, I will now provide an insight of some of the additional concepts gravitating in the universe of risk, in particular *risk analysis*, *risk management* and *risk communication*, together with *risk characterization* and *risk tolerability*.

Generally used to summarize the whole process of *risk assessment, risk management and communication*, risk analysis is defined in a number of glossaries. The White Paper on Risk Governance lists some examples, namely:

1. A systematic use of available information to determine how often specified events may occur and the magnitude of their consequences (Aus/NZ Standard)
2. A process consisting of three components: risk assessment, risk management and risk communication (Codex Alimentarius);
3. A process comprising four components: hazard identification, risk assessment, risk management and risk communication. (FAO-EMPRES);
4. Method of evaluating the probability of the adverse effects of a substance, industrial process, technology or natural process. (European Environment Agency)
5. Efforts to ascertain […] the probability of occurrence of concrete damaging events or the probability function of magnitude of damages. Risk analyses aim to determine the expected value of a risk. (German Advisory Council on Global Change);

[102] As it will be explained in Chapter 4, several European regulations reflect the distinction between *intrinsic* and *extrinsic* vulnerability by providing indicators for measuring the former. The rationale behind is that at an equal distance, subjects may react differently depending on their health condition and the conditions of their exposure.

6. A process for controlling situations where an organism, system or (sub) population could be exposed to a hazard. The risk analysis process consists of three components: risk assessment, risk management and risk communication. (IPCS).

As in the definitions of risk reported above, these definitions agree on one, obvious, point: risk analysis is about evaluating the likelihood and consequences of events. A second point of agreement concerns the phases of risk analysis, mostly regarded as a *process*: risk assessment, risk management and risk communication. Accepting this distinction in principle, according to the definition of risk provided above risk analysis in the context of major accidents and land use planning can be defined as:

> *The process aimed at assessing the likelihood of losses or disruption of lives, goods and options humans value due to one or the interaction of more hazardous events*.

Based on both quantitative and qualitative evaluations, outcomes of risk analysis are the characterization of the hazardous events the system of reference is likely to be subject to, its intrinsic and extrinsic vulnerability and their tangible and intangible consequences, both immediate and long-term. Having clarified the distinction of "essential" and "multi-dimensional" nature of major accident risk, and having provided some guiding definitions useful to support its interpretation in the context of the research, I will again refer to the work of Renn to introduce some key-of-readings of the regulatory and methodological aspects if its prevention. To do so I will first reproduce the "knowledge characterization" of risks he provides in the Working Paper on Risk Governance[103] in Table 2.

[103] O. Renn (2005), *op. cit*., at 16.

Table 2 - Risk Characteristics and their Implications for Risk Management according to the classification of the White Paper on Risk Governance (after O. Renn 2005)

Knowledge characterization	Management Strategy	Appropriate instruments	Stakeholder participation
1. "Simple" risk problems	*Routine-based:* (tolerability/ acceptability judgement) (risk reduction)	→ Applying 'traditional' decision-making • Risk-benefit analysis • Risk-risk trade-offs Trial and error • Technical standards • Economic incentives • Education, labelling, information • Voluntary agreements	Instrumental discourse
2. Complexity induced risk problems	*Risk-informed:* (risk agent and causal chain)	→ Characterising the available evidence • Expert consensus seeking tools: o Delphi or consensus conferencing o Meta analysis o Scenario construction, etc. • Results fed into routine operation	Epistemological discours
	Robustness focused: (risk absorbing system)	→ Improving buffer capacity of risk target through: • Additional safety factors • Redundancy and diversity in designing safety devices • Improving coping capacity • Establishing high reliability organizations.	
3 Uncertainty Induced risk problems	*Precaution based:* (risk agent)	→ Using hazard characteristics such as persistence, ubiquity etc. as proxies for risk estimates Tools include: • Containment • ALARA (as low as reasonably achievable) and ALARP (as low as reasonably possible) • BACT (best available control technology),etc.	Reflective discourse
	Resilience focused: (risk absorbing system)	→ Improving capability to cope with surprises • Diversity of means to accomplish desired benefits • Avoiding high vulnerability • Allowing for flexible responses • Preparedness for adaptation	
Ambiguity induced risk problems	*Discourse based:*	→ Application of conflict resolution methods for reaching consensus or tolerance for risk evaluation results and management option selection • Integration of stakeholder involvement in reaching closure • Emphasis on communication and social discourse	Participative discourse

The area in grey is where the matter of land use planning in the context of major accident risk seems to belong to. Within it, several concepts compare, namely:

1. Precaution,
2. ALARA, ALARP, BACT,
3. Resilience (of the absorbing systems),
4. Vulnerability,
5. Preparedness, and
6. Reflective discourse.

As I will extensively demonstrate in the following of the book, these concepts are differently interpreted by and hence reflected in the legislations of the countries analyzed in Chapter 4. In particular, the precautionary principle has not found an explicit application in the context of major accidents risk, together with the concept of resilience of the urban and environmental systems. Furthermore, the evaluation of vulnerability of the environmental system with respect to the consequences of major accidents is still missing a corpus of agreed criteria and indicators.

In order to conclude my overview of the concepts gravitating in the universe of risk, those among these concepts which are more relevant to the analyses of Chapter 3 and 4 are briefly introduced.

1.4.1 Precaution

As well known, the precautionary principle (in the following: PP) is a rather controversial legal principle and it has therefore been object of a lively debate among scientists and policy makers. Its applicability and, sometimes, very necessity are fiercely debated in applied as well as policy science[104]. Yet it is one of the principles of the Treaty establishing the EU[105] and it has been object of one articulated Communication of the European Commission[106]. Without exploring this controversy in detail, I will recall the PP in general and will mention the controversies more relevant to this study[107].

Useful in this direction is the definition adopted by the European Environment Agency: "*in order to protect the environment, a precautionary approach should be widely applied, meaning that where there are threats of serious or irreversible damage to the environment, lack of full scientific certainty should not be used as a reason for postponing cost-effective measures to prevent environmental degradation*".

Precautionary approach and *precautionary principle* could seem different (Adam 2002). However the first derives from the second, even though its definition is still object of different interpretations by the side of scientists and policy-makers (Bodansky, 1991; Ramchandani and Pearce 1992; Graham 2001)[108] . A precautionary approach embodies notions of cautions, care, preventative action, common sense and responsibility. According to O'Riordan, its vagueness may actually be its strength, as in not providing codes of conduct to policy makers it obliges them to

[104] As Arcuri reports in her work […] *none of the other principles that are important in the governing of catastrophic risks, such as the prevention principle, the polluter-pays principle or the proportionality principle are as controversial; nor they have received as such opposition as the precautionary principle* […]". A. Arcuri (2005), *op. cit*., at 97.

[105] Article 130(r) of the Treaty Establishing the European Union, OJ C 191, 29 July 1992

[106] Communication from the Commission on the Precautionary Principle, COM (2000)1, 02.02.2000

[107] For an overview of the different definitions of the principle I suggest to refer to the inventory provided by Annex B of the *White Paper on Governance*, O. Renn (2005), *op. cit*., at 140.

[108] Reported by M. Adams, (2002), The Precautionary Principle and the rhetoric behind it, Journal of Risk Research, Vol. 5, pp. 301-316, at 302.

capture and argue over the ethical and moral issues driving decision making processes in conditions of uncertainty[109]. I will therefore avoid the – indeed unnecessary - effort of *defining* precaution, and I will concentrate on its *possible* utility in the context of land use planning in Seveso areas by referring to the definition of principle proposed by the European relevant communication.

The PP deals with all situations in which a full scientific certainty over the consequences of activities and / or choices on the environment is missing. In the Communication of the European Commission, precautionary policies should be proportional, non-discriminatory, consistent, based on the examination of costs-and-benefits, subject to review and capable of assigning the burden of proof. Yet the "hard version" of the principle, when translated in practice, is interpreted by many of its opponents as a chain on the foot of technology and as a belt to economical development; to mention one of them, "[…] *the precautionary principle blocs innovation and thus hampers economic and social development*" (Hanekamp 2001)[110]. I referred to "hard version" of the PP because, if the application of the principles allows only technologies and products about which there is a full scientific *certainty* over their effects, indeed society should ban a number of technologies and products it already depends on, stopping in so doing also the research investments on a even greater number of new ones. Seveso industries could easily fall in this case.

However, this may not be the spirit of the PP. In the following of the communication, the European Commission states "[…] *an assessment of the potential consequences of inaction and of the scientific evaluation should be considered by decision-makers when determining whether to trigger action based on the precautionary principle* […]"[111]. Clearly, the decision to trigger the precautionary principle should be based on the *potential consequences of inaction*; the decisional process should be hence aimed at bringing to light the "known-unknown" and the "unknown-unknown" emerging from the scientific analysis and evaluating the magnitude of the consequences which may derive from inaction.

The interpretation of the principle given by Stirling and reported below is more consistent with this "soft" version of the PP, where the principle is interpreted as a process aimed at explicating the degree of uncertainty and ignorance underlying scientific evaluations. In this view the PP is fully consistent with science-based policy; its application should regard the cases of *large epistemic uncertainties* rather than the cases on *non-full certainty*. In this perspective, the principle is a "practical conceptual corollary to science-based decision-making"[112].

In order to argue over the applicability of the precautionary principle in the context of MA risk it is therefore necessary to define whether such risks are characterized by *large epistemic uncertainty*, or by *lack of full certainty*. To do so, I will refer to the works of several Authors.

In the booklet of Amendola over the recent paradigms and topics in risk assessment, the part addressing the role of the precautionary principle doesn't refer explicitly to the prevention of MA risk [113]. However, the Author acknowledges the conclusions of Stirling over the absence of tension between *precaution* and *science-based* regulation, mentioning in particular the part of one of his contributions in which Stirling alleges […] *the key elements of a precautionary approach are entirely consistent with sound scientific practice in responding to intractable problems such as "ignorance" ("we don't know what we don't know") and "incommensurability" ("we have to compare apples and pears")*(…). *The acknowledgments of such difficulties under a precautionary*

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[109] T. O'Riordan and A. Jordan (1995), The precautionary principle in contemporary environmental politics, Environmental Values, Vol. 4, pp.191-212.
[110] Reported by R. Jongejan (2005), *op. cit*., at 56.
[111] Communication of the European Commission over the Precautionary Principle, at 7.
[112] M. Adams (2002), *op. cit*., at 301
[113] A. Amendola (2001), *op. cit*., at 12

approach may thus be seen as a more scientifically rigorous way of carrying forward the regulation of technological risk than would be their denial under a purely risk-based approach […][114].

In one work of Klinke and Renn preceding the White Paper on Risk Governance the Authors seem to hang in favour of a risk-based approach to what they label as "sword of Damocles" risks. In the famous article over the six classifications of risk recalling ancient Greek mythology[115], the Authors classify MA risk in the category of Damocles, wherein risks have a high disaster potential and a very low probability of occurrence. Both are relatively well known. The closest category to Damocles are the risks of Cyclops, wherein the still disastrous potentials are of low probability but highly uncertain. Within this category the Authors identify natural risks such as earthquakes and pandemic infections. In both cases, the recommended policy approach is risk-based, with a mixture of risk-based and precaution-based approaches only for the risk class of Cyclops. In the section over the "three management styles" the Authors allege: […] *The risk classes Damocles and Cyclops require the application of risk-based strategies and regulation. Nuclear energy, large chemical facilities, dams, nuclear early warning systems are obvious examples.* S*ince the damage component is the one that triggers concern, risk managers should concentrate their efforts on reducing the disaster potential* […][116]. In this contribution, the applicability of the precautionary principle to the case of MA risk is therefore not explicitly recommended, although a "fuzzy area" between the six classes of risk and a flexible interpretation of their classification should be accounted.

At this point, I would conclude that it is not possible to recommend the general application of the PP in the context of MA risk without having first established the degree of uncertainty emerging from their analysis on a case-by-case basis and without having clarified which consequences are considered in their evaluation. Although this may seem a poorly ambitious conclusion, it is fully consistent with the discussion developed before. In a mono-dimensional perspective, the degree of uncertainty of major accidents risk analysis is mostly due to the subjectivity of expert judgments (Amendola 2001) and the lack of historical data or *imperfect knowledge* (Christou 1998)[117]; "*as a result, the output of the consequence assessment is characterized by the presence of many uncertainties"*[118]. In a multi-dimensional perspective, considering more aspects of the reaction of a given context to the occurrence of an accident (like the social and political consequences) this uncertainty is likely to increase rather than decrease. Whereas this has to lead to the adoption of a precautionary approach depends on the type of dangerousness considered, the magnitude of the scenarios analyzed and the intrinsic and extrinsic

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[114] A. Stirling (1999), *On Science and Precaution in the Management of Technological Risk*, Joint Research Centre, IPTS, EUR 19056 EN, at 7. Reported in A. Amendola (2001), *op. cit.*

[115] A. Klinke and O. Renn (2002), A new approach to Risk evaluation and management: risk-based, precaution-based, and discourse-based strategies, Risk Analysis, Vol. 22, pp-1071-1094

[116] With respect to this interesting work I would like to address two remarks. The classification of MA risk within the category of Damocles appears somehow contradictory to the classification given by the same Author in the following White Paper, wherein the inherent uncertainty characterizing major accidents risk is acknowledged: here, MA risk appears as a sort of Cyclops risk rather than a Damocles. I would therefore suggest to regard the six classes of risk provided in the first contribution as suitable to a flexible interpretation. The second remark regards the appropriateness of classifying nuclear risk and risk posed by "large chemical facilities" under the same category: as discussed before, the ethical and technological features associated to these risks may be fundamentally different.

[117] For the explanation of the concepts of stochastic uncertainty and imperfect knowledge in consequence assessment refer to M.D. Christou (1998), "Consequence Analysis and Modeling", in C. Kirchsteiger (eds), *Risk Assessment and Management in the Context of the Seveso II Directive*, Elsevier.

[118] *Ibid,* at 209

vulnerabilities of the surrounding context in a given period of time. *"The analyst and the decision maker should be aware of these uncertainties and take them into consideration in risk-related decisions"*[119].

In all cases in which to a high degree of uncertainty severe consequences may correspond, and in which a precautionary approach may enhance their consideration by the side of analysts and decision-makers in a mutually collaborative manner, the debate over the desirability of application of the principle becomes a more unfruitful discussion than the discussion promoted by its practical application. A more comprehensive discussion on this point will be therefore developed in section 3.4.1.

1.4.2 ALARA, ALARP, BACT

The acronyms above are guiding principles for a number of risk regulation policies in Europe in the field of industrial risk prevention. In the Netherlands, the ALARA principle (As Low as Reasonably Achievable) is implemented in the regulation of MA risk in order to maintain a constant risk-reduction approach (Ale 2006). In the UK, the ALARP principle (As Low as Reasonably Practicable) is also a main guiding principle for industrial risk prevention (HSE 2004:2008; Ale 2006). The difference between the two acronyms is mostly semantic: the evaluations of what is *achievable* and of what is *practicable* are leading to rather similar conclusions[120].

The *ratio* of the ALARA principle is not matching a given tolerability level, but to the contrary reducing risks to the lowest possible extreme (HSE 2008). However, "room for interpretations" led many industries and local authorities to consider the regulation satisfied by the mere application of the principle up to the satisfaction of tolerability thresholds, i.e. to the "higher" extreme prescribed. A better understanding of the ALARP principle is therefore the one focusing on the continuity of its application in time: the technologically obtainable lowest risk is usually not what regulation sets as a limit (for example 10^{-6}), but what is dynamically achievable by means of a continuous effort in reducing it to the lowest achievable extreme.

An interesting work of Ersdal and Aven (2008) approaches the matter of the ALARA application from a philosophical perspective[121]. The Authors refer to the principle as the "reversed onus of proof", which implies that all identified risk reduction measures should be implemented *unless* it can be demonstrated that there is a gross disproportion between costs and benefits. To verify ALARP, codes and experts judgments are used together with cost-benefit analysis and guidance values. Values are here used to judge what is "gross disproportion" for instance. The ALARP is usually applied in a three-regions context, where low risk (probabilities of occurrence lower than 10^{-6}) are labelled negligible in comparison to high risks (probability of occurrence higher than say 10^{-4}). In between, the ALARA principle works "actively" and should be regarded as the continuous effort in reducing risks. Even here, the Authors agree that […] *the focus of the general ALARP principle for obtaining a good solution with respect to safety and cost can easily*

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[119] *Ibid*

[120] This is, however, not completely correct. The ALARP principle adopted in the UK safety system differs in nature from the internationally used ALARA. The legal implications of *reasonably practicable* and *achievable* may be in fact different. The former balances costs/benefits until a large disproportion subsist (UK Case Law, reported by HSE 2008); the latter may be subject to less stringent interpretations as it may consider only the resources at disposal under given social and economical circumstances. However, in this book ALARP an ALARA are used interchangeably.

[121] G. Ersdal and T. Aven (2008), Risk informed decision-making and its ethical basis, Reliability Engineering and System Safety, Vol. 93, pp. 197-205.

be lost by the focus on the acceptance criteria (tolerability limits) […]"[122]. Given these premises and focusing on MA risk, the application of ALARP principle seems to respond to the definition of safety given by Weick as "a dynamic non-event"[123], whereas "dynamic" indicates the constant improvement of safety measures and the continuous verification of their performance in order to guarantee the "non-event" represented by the condition of safety. As I will examine in the following of the book, the ALARA / ALARP principles are indeed a well established guidance for operators and authorities of a great variety of countries. Yet its interpretation as constant risk-reducing strategy is applied with different degrees of strictness.

The BACT is a second guiding principle for the prevention of MA risk and it is explicitly mentioned among those Germany refers to in its major hazards regulation[124]. The ratio of BACT is that […] *the observation and implementation of the Best Available Technology should guarantee that the residual risk posed by the establishment outside its boundaries is minimal* […] (German Safety Authority 2007). This guiding principle has hence a different character than the previous two: the focus is on the plant and hence on the reduction of risk at source.

It has to be stressed that the application of ALARA /ALARP and BACT are obviously not mutually excluding. On the other hand, the major stress of one of the two reveals a different policy approach to the matter of MA risk. These aspects will be further discussed in the Chapter dedicated to the comparison, among other issues, of the interpretation and application of these guiding principles in the selected national practices.

1.4.3 Vulnerability and Preparedness

The vulnerability of humans and the environment as the criteria for evaluating risk prevention measures is an extensively treated topic in literature and find increasing adoption within European regulations.

The Environmental Impact Assessment Directive (EIA) can be seen as the first legislative instrument referring to these concepts explicitly[125]. However, the difference between the vulnerability analysis required by the EIA and the one deriving from the implementation of the Seveso Directives is fundamental. In the siting process, EIA does not take into account the risk of accidents, as it is devoted to the analysis of the continuous emissions produced by establishments during ordinary operational conditions. The EIA process ends at the time of siting (Amedola 2001), as it aims at the creation, identification and selection of siting alternatives for industrial activities which are then supposed to "provoke" their ordinary impacts (Kværner *et al* 2006). The evaluations to be carried out to comply with the Seveso requirements are instead meant to assess the

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[122] G. Ersdal and T. Aven (2008), *op. cit*., at 204.

[123] K. Weick (1987), *Organizational Culture as Source of High Reliability*, California Management Review.

[124] SFK/TAA-GS-1, *Recommendations for separation distances between establishments under the Major accidents Ordinance and Areas requiring protection within the framework of Land-Use Planning - Implementation of Federal Pollution Protection Law (BImSchG)*, 2005, online. Available at: http://www.kas-bmu.de/publikationen/sfk_gb/sfk-taa-gs-1k-en.pdf (short version; last visited: November 2007). The term used in this guidance is, more precisely, "State of Art of Safety Technology", wherein "state of art" replaces "best available" and "safety" replaces "control".

[125] The EIA Directive on Environmental Impact Assessment of the effects of projects on the environment was introduced in 1985 and was amended in 1997 by Council Directive 97/11/EC of 3 March 1997 on the assessment of the effects of certain public and private projects on the environment, OJ L 73, 14.3.1997, p. 5–15. Following the signature of the Aarhus Convention by the Community on 25 June 1998, the Community adopted in May 2003 Directive 2003/35/EC of the European Parliament and of the Council providing for public participation in respect of the drawing up of certain plans and programmes relating to the environment, Official Journal L 156 , 25/06/2003 P. 0017 – 0025. The last Directive amends among others the EIA Directive of 1997.

extraordinary impacts of activities, i.e. accidents. In conclusion, the Seveso process begins where the EIA process ends.

Kværner *et al* (2006) explored the various meanings of the term *vulnerability* in several disciplinary contexts[126], finding their common denominator in the changes the exposed natural and cultural environments are called to face when copying with external impacts[127]. Nevertheless the concept remains extremely sensitive to the disciplinary as well as operational contexts in which evaluations are performed; therefore "[…] *An objection which can be raised against a vulnerability concept at a framework level is the restricted applicability in some disciplines* […]"[128]. It is therefore preferable to look at the way the concept can be operationalized in the context of major accidents risk prevention rather than searching for a universally applicable definition.

A clear contribution in this direction is represented by the work of J. Tixier *et al* (2006) on the evaluation of vulnerability in the vicinity of an industrial site falling under the Seveso II requirements[129]. The approach seems to mould the footprints of the majority of approaches adopted by European countries for the vulnerability assessment in the context of the Seveso II. The basic idea is defining a vulnerability index against which measuring the vulnerability of all possible targets located in the surroundings of industrial sites, i.e.: *mapping the vulnerable targets*:

Table 3 – the classification of targets according to three categories of vulnerability (elaboration from J. Tixier, 2006)

HUMAN	ENVIRONMENTAL	MATERIAL
◦Staff of the site ◦ Local population ◦ Population in an establishment receiving public ◦ Users of communication ways	◦ Agricultural areas ◦ Natural areas ◦ Specific natural area ◦ Wetlands and water bodies	◦Industrial site (*M*1) ◦ Public utilities and infrastructures ◦ Private structures ◦ Public structures

The evaluation of the vulnerability of humans to the consequences of major accidents relies on experimental data regarding the health effects of exposure to overpressure, temperature and toxic doses. This is what I called *intrinsic* vulnerability. More difficult is the evaluation of vulnerability of the natural environment and the "mapping" of other forms of intangible vulnerabilities, like the lack of preparedness of the involved communities on how to cope with the occurrence of accidents. At the beginning of his article, Tixier points out that "[…] *In a general way, decision-taking is a complex process which is not only based on a set of information about a subject, but depends also on the representations of the members of the decision group regarding their vision of the reality. Furthermore, personal preferences and persuasion can have more importance in the process of decision than a clear and rigorous logic* […][130].

[126] J. Kværner, G. Swensen and L. Erikstad (2006), Assessing Environmental vulnerability in EIA. The content and context of the vulnerability concept in an alternative approach to standard EIA procedure, Environmental Impact Assessment Review, No. 26, pp. 511–527

[127] I question whether the term *external* is here used correctly, as I would regard the sources of impacts as rather *internal* to the complexity of the human-environmental system.

[128] Kværner *et al* (2006), *op. cit*., at 520.

[129] J. Tixier *et al* (2006), Environmental vulnerability assessment in the vicinity of an industrial site in the frame of ARAMIS European project, Journal of Hazardous Materials, Vo. 130, pp. 251–264

[130] J. Tixier *et al*, *op. cit*., at 253.

In conclusion, the inventory of vulnerable targets accordingly to given criteria and quantitative indicators does not provide a comprehensive base for taking risk reduction decisions; however, their provision is an essential element of the European legislations regulating the land use evaluations in at-risk areas. This point will be extensively treated in Chapter 4.

1.4.4 Resilience

The concept of *resilience* is finding increasing credit and application in urban and environmental planning studies[131]. Although it has no direct application in the context of this book, it is one of the terms that compare in the context of the European projects on risk and land use planning mentioned in the Introduction. A short account is therefore provided. The White Paper on Risk Governance refers to resilience as "*A protective strategy to build in defenses to the whole system against the impact of the realisation of an unknown or highly uncertain risk. Instruments for resilience include strengthening the immune system, designing systems with flexible response options, improving emergency management etc*."[132]. The Glossary compiled in the context of the ARMONIA Project refers to resilience as "*the capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to restore or maintain an acceptable level of functioning and structure*"[133].

The concept emerged from ecological theories in the 1960s and early 1970s and builds upon complexity and system theories (Gallopin, 2006; Cadenasso *et al*, 2006). According to the given definitions, *resilience* refers the capacity of systems to adapt to perturbations and (un)predicted changes. Eco-systemic resilience is defined by the Resilience Alliance[134] as "*the capacity of an ecosystem to tolerate disturbance without collapsing into a qualitatively different state that is controlled by a different set of processes. A resilient ecosystem can withstand shocks and rebuild itself when necessary. Resilience in social systems has the added capacity of humans to anticipate and plan for the future*". According to Folke, the systems ability to re-organize itself relates to the capacity of the system to tolerate and deal with changes. Resilience is not only about being persistent or robust to disturbance, but it is also about the opportunities that disturbance opens up in terms of recombination of evolved structures and processes, renewal of the system and emergence of new trajectories[135].

In the context of major accidents risk, resilience can be seen as the counterpart of vulnerability; a resilient system is the system capable to react to perturbations adapting and re-organizing itself rather than loosing its vital functionalities. This is why the term may be associated with *copying capacity* and finding increasing application in the context of emergency planning studies. Notwithstanding this concept will not find application in the context of this book, mostly due to the lack of its explicit utilization in the analyzed national methodologies and the following

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[131] Refer among others to P. Schmidt-Thomé *et al* (eds.), *Glossary of a Multi Hazard Related Vulnerability and Risk Assessment Language – Final version*, Deliverable nr. 4.1.2, Armonia Project, 2007

[132] O. Renn (2005), *op. cit*, at 79. Annex I reports two others definitions, namely "*The capability of a system to return after deflection or perturbation to a stable overall or local state of equilibrium*" (German Advisory Council on Global Change), and "*The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure*" (UN Living with Risk Report). I regard all definitions as consistent with the problem of MA as "perturbing events" and the adaptive capacity of the perturbed system to maintain an acceptable level of functioning by means of a flexible and adapting response.

[133] P. Schmidt-Thomé *et al* (2007), *op. cit.,* at 13

[134] Online, http://www.resalliance.org/1.php Last visited: November 2007

[135] C. Folke et al (2005), Adaptive governance of social-ecological systems. Annual Review of Environment and Resources, No. 30, 441-473.

comparison, it is one of the concepts to be acquired when approaching risk in land use planning studies.

1.4.5 Reflective discourse

The definition of reflective discourse given in the White Paper on Risk Governance is "(The) *Collective reflection on the course of action to take e.g. balancing possibilities of over- and under-protection in the case of large remaining uncertainties about probabilities and/or magnitude of damage(s). Examples of reflective discourse include round tables, open space forums and negotiated rule making".*

The "collective reflections on the course of actions to be taken" is, in theory, rather familiar to land use planning processes in the context of the Seveso Directives. As I will describe in Chapter 4, there are established consultation processes in all the land use planning procedures of the analyzed countries, though the instruments, the consultation methods and the concrete results of consultations may differ. Generally in Europe the local level of planning is a process of allocation of land uses accordingly to the general objectives defined into municipal plans. These planning instruments have a public character and are usually submitted to public consultation prior to their adoption: depending on the level of inclusion *of* and the openness to negotiation *with* the public (which ranges from the consensus-driven Dutch to the consultation-driven Italian approaches) the adoption of a municipal plan is the point of arrival, and not the line of departure of the allocation of uses to the territory. However, the different degrees of inclusion of the public in the process are a non-secondary aspect.

Analyzing this aspect of potential "siting controversies" is out of the scope of this book. However, there is a general agreement that in the last decades a *consensus-driven* approach has substituted the *decide, announce and defend* approach originally adopted by industries and authorities (Kasperson 2005)[136]. As analyzed in Chapter 3, the Seveso Directives are strongly information-oriented; informing stakeholders at various levels is a key-requirement of the Directive Seveso II. In Chapter 3, 4 and 5 will demonstrate how the provision of information does however differ from the inclusion of the public within decision-making processes, and how the very provision of information may be significantly different depending on the legislative and cultural contexts of evaluations.

1.5 Concluding remarks

In this Chapter, several interpretational instruments suitable to support the reading of the book where provided. The historical background of the matter of major accidents risk, some reflections on the paradigm of risk society, the main definitions in use in the context of risk analysis and some clarifications of the relevant "terminology battlefield" were proposed. A summary of the main considerations and conclusions is given in the following.

The roots of industrial risk dates back to the XVII century and the first regulations addressing the matter of the siting of dangerous facilities were issued under Napoleon. Whilst it is indubitable that the nature of dangers and their territorial diffusion have changed in time, dating the advent of the "risk society" back to the second half of the past century may be a misleading conclusion. Furthermore, considering modern technological risks equally represented by nuclear risks may lead to misleading generalizations: different industrial technologies are characterized by unique features and their consequences have rather specific characters, such as systemic vs. site-

[136] See R. Kasperson (2005), "Siting Hazardous Facilities: Searching for Effective Institutions and Processes", in S.H. Lesbirel and D. Shaw (eds), *Managing Conflict in Facility Siting. An International Comparison*, Edward Elgar Publishing Limited, Cheltenham UK

specific and irreversible vs. intergenerational. It is by eliciting these features that a categorization of different industrial risks become a useful exercise.

Risk is a multi-faced concept of no univocal definition. However, different definitions of risk may lead to different risk evaluations. In the context of major accidents risks, the variable of vulnerability shall be extrapolated from the "risk function" and hence considered in its extrinsic (positional) and intrinsic (related to the nature of targets) aspects. Furthermore, a mono-dimensional characterization of the consequences risk is useful to rank different degrees of dangerousness and consequences and providing a quantitative guidance to decision makers; however, also intangible and long-term consequences should be considered. This is why a definition of risk as *the possibility of losses or disruption of lives, goods and options humans value* is proposed.

The uncertainty of the *ex-ante* evaluation may become, in this case, even higher than in the ordinary practices. The fuzziest the definition, the bigger the room for interpretation. However, in the following of the book its relevance to the *ex-post* analysis of world famous accidents will be clarified.

The Chapter concludes with providing some preliminary explanations of the main concepts gravitating in the universe of risk and in use in European national legislations. Whereas this description lead only to minor elaborations, it enables the reader less familiar with the matter of risk of major accidents in reading the following Chapters.

CHAPTER 2

Learning by accidents

If the accident happens tomorrow,
would we then still believe
that the risk was acceptable?

B.J.M Ale, 2007

The intention of this Chapter is providing a more insightful description of the phenomenon of major accidents. To this scope, three case-histories of major accidents are reported, namely the accident of Seveso, Italy, 1976; the accident of Bhopal, India, 1984, and the accident of Toulouse, France, 2001.

These events have significantly influenced the evolution of the Seveso Directives until the most recent developments. Their description will serve to address some concluding remarks concerning the matter of defining major accidents risk, the matter of defining their acceptability and the role of land use planning for the prevention of their consequences. To do so I will refer, among others, to the case-histories collected by F. Lees[137]. Among the tens of cases reported in his comprehensive work, I opted for those accidents whose "lessons learned" have had a direct influence on the European regulatory developments. Furthermore, I selected the accidents whose developments have been primarily influenced by the lack or insufficiency of appropriate land use and emergency planning measures.

2.1 Seveso: a tragic case of *un-preparedness*

The accident at the ICMESA Chemical Company in Meda, a village nearby Milan, is considered the corner-stone of the "lessons learned" from accidents involving the release of dangerous substances (Lees 1996). This is due to several factors, among which the highly dangerous substance involved (the 2, 3, 7, 8-tetrachlorodibenzo-p-dioxin, known as TCDD or dioxin), then among the most toxic known, and the dramatic sequence of delays and inefficiencies occurred both during the emergency response and the aftermath of the event. The fact that the accident provoked a release of a highly toxic substance (which can be spread by means of predominant winds up to a considerable distance from the source of emission) demonstrated how the "impact" of accidents cannot be limited to the immediate surroundings of the plant: the complexity of the meteorological and geographical conditions of the territory surrounding hazardous facilities plays a role in the development of associated scenarios. In Seveso, such

[137] F. Lees (1996), *op. cit*. The accident of Tolouse, which occurred after the publicaiotn of the work of Lees, is the only one for which I referred to a different sources. See paragraph 1.3.2 for the complete references.

scenarios were totally unknown: as reported by De Marchi *et al* in their comprehensive analysis of the "paradoxical classical disaster" of Seveso, neither the population nor the regional and local authorities were minimally aware of the hazard associated with the "fabric of perfumes", as ICMESA was nicknamed[138]. The fact that the seriousness of the accident was recognized only gradually involved the community in rancorous conflicts and worsened the psychological consequences of the event in the entire region. In short, the accident brought to the attention of the whole European public not only the matter of the siting of dangerous facilities and the risks represented by their vicinity to urbanized (in this case, also rural) areas, but also the risks associated with the incapacity of communities to respond to such events because of the lack of information concerning the nature of the hazards they are exposed to (De Marchi *et al* 1996).

The ICMESA establishment became operational in 1946 and was sited in a then clear area, surrounded by fields and woods. Over the years the lack of appropriate planning policies allowed the construction of residences and infrastructures in the vicinity of the plant, though the "character" of the territory remained rural for many years[139]. Although the accident affected the entire Brianza, a prosperous region nearby Milan, the municipalities of Meda (19.000 inhabitants), Desio (33.000) and Cesano Maderno (34.000) were the most affected together with Seveso(17.000 inhabitants at the time of accident), which was more exposed due to the vicinity to the establishment (De Marchi *et al* 1996).

At 12.37 on Saturday 9 July 1976 a bursting disc ruptured on one of the chemical reactor of the establishment. Following the rupture "a dense cloud of considerable altitude"[140] was released for about 20 minutes.. The release contaminated the surroundings of the plant with dioxin. Three zones of contamination were individualized: zones A and B, of 1.08 and 2.68 km^2 respectively, and a respect zone "R". In the first zone, the concentration of dioxin reached 5000 µg /km^2, in the second a concentration of 43 µg / km^2 while in the third of 5 µg /km^2 (Lees 1996) [141]. Fig 3 illustrates these zones and provides a general overview of the territory surrounding the ICMESA plant.

[138] B. De Marchi, S. Funtowicz and J. Ravetz, "Seveso: A Paradoxical Classical Disaster", in J. K. Mitchell (eds.), *The Long Road to Recovery: Community Responses to Industrial Disaster*, Tokyo, [etc]; United Nation University Press, online. Available at: http://unu.edu/unupress/unupbooks/uu211e00.htm/ . Last visited: April 2008

[139] At the time of accident of Seveso urban planning and territorial planning, at municipal and provincial levels respectively, were performed on the basis of the first national Urban Law that Italy adopted in the middle of the Second World War, precisely in 1942 (refer to G. Ciucci and G. Muratore, 2004, "Pagine di Storia: la Legge del 1942. Il percorso disciplinare e culturale che conduce alla legge urbanistica", in *Storia dell'Architettura Italiana: Il Primo Novecento*, Electa, Milano). At the time of the accident of Seveso the siting of dangerous installations was hence falling under the responsibility of the Central Government.

[140] Orsini (1977), *Seveso Report.* In F. Lees (1996), op. cit., Appendix 3/7, Vol 3.

[141] The toxicity of chemical substances is assessed against the LD_{50} (µg/kg) index, which corresponds to the experimentally deducted lethal dose within the first 50 minutes of exposure of cavies. For dioxin, this dose ranges between the 0.6 for Guinea pigs up to the 115 for rabbits (refer to F. Lees, *op. cit*., Appendix 3/7).

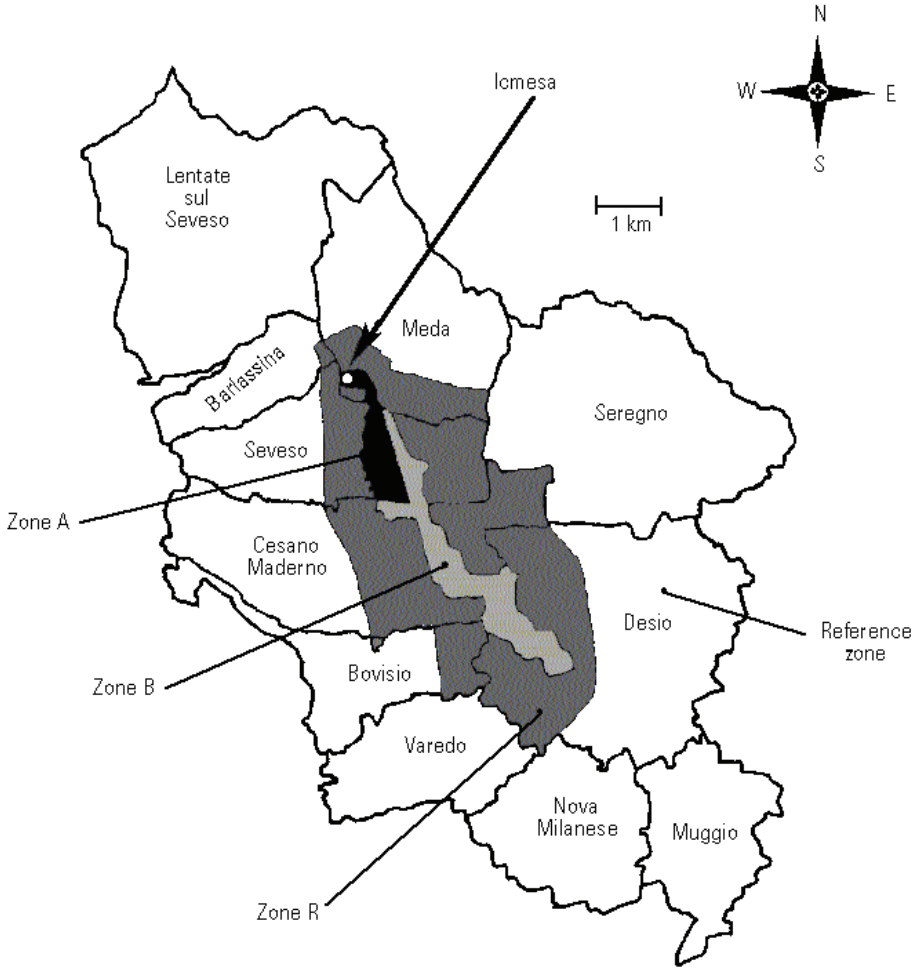

Fig 3 – the contaminated zones A, B and R resulting from the release of dioxin from the ICMESA establishment nearby Seveso, Italy (Orsini 1977; reported by Lees 1996)

As shown in the picture, the most affected area (Zone A) was the western-south side of the Municipality of Seveso, though other villages such as Cesano Maderno and Meda were polluted by considerably high levels of dioxin. In order to plan the decontamination of the site, the release was modeled using fluid jet and gas dispersion models and prediction were made about the ground level concentration of dioxin, which was agreed corresponding to an amount of 2 kg in total (Lees 1996). Various methods of decontaminations were put forward by several parties. The soil in and surrounding Seveso kept being monitored until recent years.

Once the release was contained on site, workers started to alert the population living in the vicinity of the plant, warning them to not eat vegetables from their garden and avoiding leaving their houses. The local army (the Carabinieri) refused to spread the alarm without the authorization of the local health officer: starting from this first episode, a series of miscommunications and failures in the emergency response resulted in a dramatically late evacuation of the population (733 people in total were evacuated only 16 days after the release) and in an equally late medical support to the injured, who started to be treated for *chloracne* (a skin disease) and applying for preventive abortions only several days after the occurrence of the accident (Lees 1996).

As already mentioned, the accident of Seveso is a sort of Pandora's vase from which a number of malign spirits spread all over Europe. Too many failures both in the immediate and the aftermath of the accident revealed the almost complete ignorance, by the side of the population and the public forces, about the threat they were exposed to. Enhanced by the lack of opportune planning measures preventing the urbanization of the immediate surroundings of the plant, the direct exposure of a completely uninformed population led to a catastrophe[142].

Considering the scope of this book I would like to look at the event from this last perspective in particular. As before mentioned the "history" of the developments in the vicinity of the establishment dates back to its siting in 1946. The municipality of Meda was chosen due to the strategic relevance of the rail lines connecting the village with the nearby Milan. Furthermore, the area was at the time a rural area with a low population density. 22 days after the request of edification, the Military Alliance and the Municipality granted the permit. When the fabric became operational, the area was declared "military protected zone" and theoretically, any further edification could have not been allowed[143]. Nevertheless, in the following years and particularly during the second half of the '60s, when the surroundings of Milan started to attract an increasing number of immigrants due to the working opportunities available in the region, the municipality of Seveso extended the development of residential areas up to the immediate southern boundaries of the small village where the fabric was operational.

In 1965 the company was bought first by Givaudan and thereafter by Hoffmann la Roche for the production of herbicides and antiseptics. As before mentioned the establishment became well known by the population due to the release of smelling substances. The fact that dioxin was everything but a perfume became evident once the area which had to be decontaminated (area A; refer to Fig x) up to 40 cm of depth of soil and thousands of tanks of polluted ground were moved abroad for incineration[144].

Considering the scope of this book, before concluding this brief account of the accident of Seveso I would now like to discuss an important aspect of the tragedy: which were the consequences of the accident on the following developments of the territory? How the "history" of the territory involved in the disaster has been influenced by the experience of the chemical accident and how the "long route to recovery" has been covered after its occurrence?

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[142] Prior to Seveso a number of accidents involving the release of dioxins occurred in several European and extra-European countries. The *Seveso Report* commissioned after the accident by the Italian government reports at least 15 accidents involving the release of TCDD (refer to Lees 1996). The effects of dioxins were hence already reported in literature. In particular Schulz investigated the *chloracne* caused by the contact with dioxins and demonstrated the direct role of TDCC for its insurgence (Schulz 1957). Despite this, the representatives of ICMESA did not deliver information over the effects of dioxins in the immediate aftermath of the accident: TDCC was mentioned among the released substances only 11 days after the occurrence of the accident (Lees 1996). Following the panic provoked by the "poisoning gas", as the media reported it, several pregnant women applied for preventive abortions. Considering that in 1976 the Italian law had not regulated the volunteer interruption of pregnancy yet, many of them went for surgery abroad. Fetuses analyzed in Swiss laboratories were found in healthy conditions. It is not possible to say whether these abortions could have been avoided by means of more sound information over the effects of TDCC: surely, they should be accounted as one tragic consequence of their scarcity at the time.

[143] The information over the development of Meda and Seveso following the siting of the fabric are collected from various studies, among which the already mentioned work of Arcuri (2005), the Seveso Report of Orsini (1977, reporte in F. Lees 1996) and other sources avaiable online, among which the website of the municipality of Seveso, available at http://www.comune.seveso.mi.it/ . Last visited: March 2008.

[144] With respect to the decontamination of the soil of Seveso and the transport of tanks of contaminated materials abroad, De Marchi recalls the case-history complied by Gambino *et al* and points out how the final destination of such "dirty materials" is still unclear. (De Marchi *et al*, 1996, *op. cit*.)

The decontamination of the soil started in the January of 1977, six months after the disaster (De Marchi *et al* 1996). In the June of the same year, after public pressure, the Lombardy Region set up the Special Bureau of Seveso (Italian: Ufficio Speciale di Seveso) and delegated all competences for the actions to be taken for recovering the area. In the October of the same year people evacuated from the Zone A returned to their houses and the decision to demolish the most contaminated ones was taken. In the same period the decontamination of Zone B started. Zone R was released for agricultural use in 1980[145].In the following years ICMESA paid a considerable amount of Italian liras for compensation to the municipality of Seveso, Desio and Cesano Maderno. In 1985, the Court of Appeals of Milan confirmed criminal convictions of two of the five accused managers and the demolition of the establishment begun.

The fabric of perfume was in the end replaced by a park of 43 hectares[146]. At the conclusion of the works of reclamation of the Zone A in 1983, the Special Bureau for Seveso decided to convert the area in a forest, which maintainance currently falls under the responsibility of the Lombardy Region. As argued by De Marchi *et al*, the re-conversion of the site into a commemorative park has a strong symbolic value, which gives a somehow paradoxical character to the whole tragedy: symbol of the consequences of the ignorance and in-preparedness, Seveso became a symbol of recovery and remediation[147]

Coming back to the case-history compiled by Lees, in conclusion there are several lessons which were learned by Seveso. Among them, those of major interest for the purpose of this book are[148]:

1) […] Siting of major hazard installations: the release of Seveso affected the public because in the period since the site was first occupied housing development had encroached on the area surrounding the plant. The accident underlined the need of separation between public and such hazards;
2) Hazard of ultra-toxic substances: Seveso threw into sharp relief the hazard of ultra-toxic substances. The toxicity of TCDD is closer to that of a chemical warfare than to that of the typical toxic substance which the chemical industry is used to handling. (…) The following EC Directives place great emphasis on toxic and ultra-toxic materials;
3) Planning for emergency: as the account given above indicates, the handling of the emergency was a disaster in its own right. Information on the chemical released and its hazards was not immediately available from the company. There was failure of communication between the company and the local and regulatory authorities and within those authorities. Consequently there was lack of action and failure to protect and communicate with the public. These deficiencies might in part have been overcome by emergency planning.

As I will extensively describe in Chapter 2, these lessons prompt the emanation of the first Seveso Directive on the *control* of major accidents. A second version of the Directive focusing on the *prevention* and extending the requirements to the control of urbanization in the areas subject to

[145] Two years later, ICMESA, the Italian Government and the Lombardy Region undersigned a final agreement on the settlements of claim. Short afterwards, the Director of production of ICMESA Eng. Poletti was shot and killed in a terrorist attack (De Marchi *et al*, 1996, *op. cit.*, at 12)

[146] The complete history of the recovery route from the accident to the commemorative park of Seveso is reported in Fondazione Lombardia per l'Ambiente (1998), *Seveso vent'anni dopo: dall'incidente al Bosco delle Querce* (English: *Twenty years after Seveso: from the accident to the oaks park*), M. Ramondetta and R. Repossi (eds.), Milan, pp. 204

[147] B. De Marchi *et al* (1996), *op. cit*., at 9

[148] F. Lees (1996), *op. cit.*, Appendix 3/ 13

major accidents risk (Art 12) was emanated after a second, fundamental lesson: the lesson learned from Bhopal.

2.2 Bhopal: vulnerability, vicinity, fatality

As already mentioned in the Introduction, the chemical disaster occurred in Bhopal in the December of 1984 is the most tragic industrial accident in history. Beside the numbers of deaths caused by the impressive release of methyl-isocyanate, estimated between 2000 and 20.000 people counting the deaths occurred up to 1994 (Shrivastava 1996, Lees 1996), thousands of irreversible and long-term injured compare in the black-list of the consequences of the catastrophe together with uncalculated environmental damages. Furthermore, the area surrounding the plant was never decontaminated: the international efforts to promote a set of interventions in Bhopal in the aftermath of the accident remained unheard. The controversy between the mother company Union Carbide Corporation and the Indian Government before a US court was resolved with a monetary refund, against which the victims of the accident appealed without success. None of the managers of Union Carbide compared in front of an Indian court. By their side, the Indian government and particularly the municipality of Bhopal were liable for a series of fatal mistakes, especially concerning the complete absence of prevention and emergency response measures in the surroundings of the establishment, where the rapid development of densely populated slums lacking the minimal infrastructure and hygienic supplies was permitted. In Bhopal, the "victims remain victims" (Shrivastava 1996); among the case-histories compiled by Lees the disaster finds hence a privileged, though unfortunate place.

Union Carbide had 14 plants operating in India and its interests were held by Union Carbide India Ltd (UCIL). The American mother company owned a majority of UCIL, having persuaded the Indian government to waive its usual requirement for Indian majority shareholder on the basis of the technological sophistication of the plant and the export potential. The location of the UCIL works in Bhopal is shown in Fig 4 and 5:

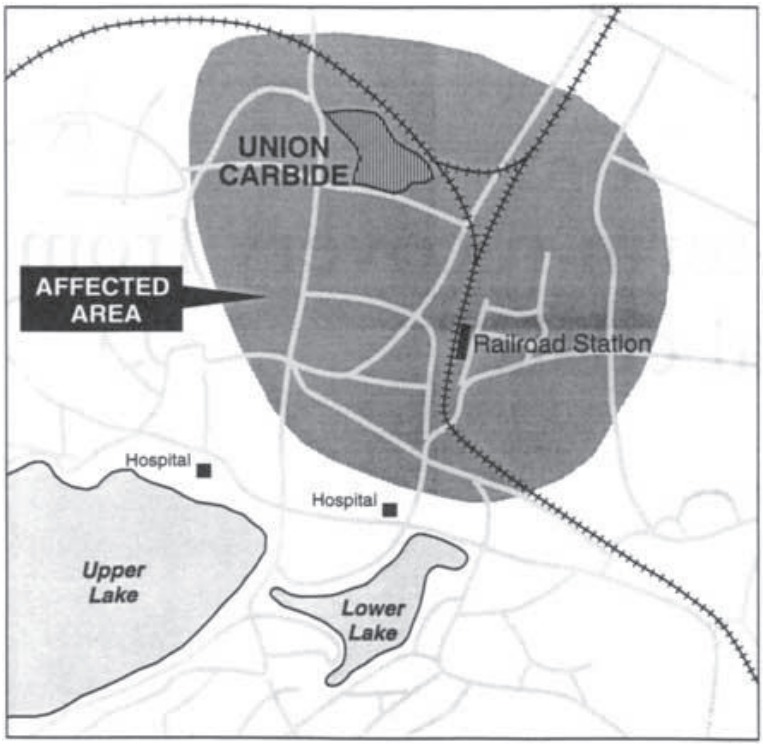

Fig 4 and 5: simplified maps of the area affected by the toxic cloud released from the Union Carbide Ltd plant in Bhopal (after Shrivastava 1996)

The establishment was located in a heavily populated area, and much of the housing development closest to the plant had occurred since the site began operations in 1969, including the growth of the J.P Nagar shanty town. Although these settlements were originally illegal, in 1984 the government gave the squatters rights of ownership on the land to avoid having to evict them. Other residential areas which were affected by the gas cloud had been inhabited for over 100 years[149].

The accident occurred in the December of 1984 was a somehow foreseen disaster, not only with regard to the safety degradation of the plant, but also in consideration of the governmental choice of permitting the development of densely populated slums in its immediate vicinity: both facts were pre-conditions of the catastrophe. Before describing the dynamic of the accident I would therefore briefly recall the work of Shrivastava, who gives a brief account of the history of Bhopal in his analysis of the disaster[150].

The city became the capital of Madhya-Pradesh state in 1947 following the Indian independence. Originally, Madhya-Pradesh was an underdeveloped, unindustrialized and poor region in the middle of the country. Following the independence and being the new seat of government, Bhopal attracted new offices, commercial activities and industries. In 1956 Indian's largest heavy electrical manufacturing plant was established in the city. Throughout the 60's the city continued to attract new industries and governmental institutions: this sudden development came surging population growth and haphazard urbanization. Shivrastava reports that from a base of 50.000 people in the mid-50's, the city grew to 102.000 in 1961, to 385.000 in 1971 up to 670.000 in 1981, surpassing 1 million in 1991.

One result of the rapid growth was the undersupply of infrastructures: at the time of the accident, housing, water supply, transportation and electricity were all inadequate together with the medical services, represented by a total of 1800 hospital beds and 300 doctors. Nearly 20 % of the population lived in 156 slum colony, many of which located alongside various hazardous facilities. The combination of high population density, poor infrastructures and inadequate medical system limited the capacity of the city to cope with the crisis and mitigate the damages dramatically (Bidwai 1984, Shrivastava 1992).

Coming back to the dynamic of the accident and referring to the case-history compiled by Lees, as above mentioned the catastrophe was somehow announced. A series of previous minor accidents occurred between 1981 and 1984 and a report over the conditions of maintenance of the plant was issued in early 1982. At that time a UCC safety team visited the establishment and gave a generally favorable summary of the state of the establishment, if not for three safety concerns, among which the "[…] *potentials for release of toxic materials in the phosgene/MIC unit areas and storage areas, either due to equipment failure, operating problem or maintenance problem*"[151].

MIC is a colorless liquid derived, among other substances, from phosgene. It is relatively stable when dry but highly reactive with water. MIC is an irritant gas and its high toxicity causes lung oedema. Furthermore it breaks down in the body forming cyanide: this substance suppresses the cytochrome oxidase necessary for oxygenation of the cells and causes their asphyxiation. Cyanide was in fact the main substance found in cadavers by the Indian doctors who carried out post-mortem analysis, which were carried out to understand the treatments to be provided to

[149] Unfortunately I could not retrace any reference providing a more detailed insight of the urban regulation of Bhopal at the time of the accident. The governmental decision of conceiving ownership rights to the population of the J.P Nagar shanty town is anyway confirmed by the investigation of La Pierre reported in the Introduction.

[150] P. Shrivastava (1996), "Long-term recovery from the Bhopal crisis", in J.K Mitchell (eds.) *The Long Road to Recovery: Community Responses to Industrial Disasters*, *op .cit*.

[151] F. Lees (1996), *op. cit*., Appendix 5/5

injured: UCC didn't deliver neither detailed information over the substances involved in the accident nor provided informative support to the medical services dealing with the emergency (Shrivastava 1996, Lees 1996).

The MIC storage system consisted of three storage tanks, two for normal use (Tank 610 and 611) and one for emergency use (Tank 619). The most important safety equipments for keeping MIC stable were the refrigerator system, maintaining the temperature of the storages at 0°C, a pressure controller and a safety relief valve (SRV) protected by a bursting disc. High temperature alarm and low and high level alarms were also installed.

Following the visit of the UCC team the valves on the MIC plant were replaced, but degraded again: at the time of the accident the instruments on Tank 610 (from which the release occurred) had been malfunctioning for over a year. Between 1981 and 1984 more than one lethal accident occurred and several workers have lost their lives in one of the operations of the plant. Following a leak of hydrochloric acid and chloroform which injured three workers and nearby residents, workers from the plant posted a notice in Hindi which read: "Beware of lethal accidents…lives of thousands of workers ands citizens in danger because of poison gas…spurt of accidents in the factory, safety measure deficient"[152]. These posters were distributed in the community.

On the evening of the 2nd of December a shift change took place in the on the MIC plant and the control room operator noticed that the pressure in Tank 610 was higher than normal, though still within the operating pressure. One hour later the pressure started to increase rapidly and reached alarming levels: the operator run outside to check the state of the tank, from which screeching noise was coming together with sensible heat. When he came back to the control room and tried to activate the safety relief valve, he discovered that the circulating pump was not on: few minutes later operations in the unit were suspended due to the high concentration of MIC released by the tank and at 1.00 o'clock the toxic gas alarm was given.

The toxic cloud spread from the plant towards the populated areas to the south. People who perceived the irritant effects of the gas run our of their houses and some towards the plant. Within a short period they began to die together with animals. At Railway Colony, about 2 km from the plant where nearly 10.000 people lived, it was reported that within few minutes 150 died, 200 were paralyzed and 600 rendered unconscious together with 5000 severely affected.

The two hospitals principally concerned with the emergency were overwhelmed with casualties. The difficulties were compounded by the fact that it was not known what the gas was or what its effects were. Speculations about the gas, including suggestions that it was phosgene, continued to be spread by the world press for days. The company provided little information: initially it stated that MIC is irritant for the eye but not lethal. Following this communication, doctors at the Ghandi Memorial Hospital carried out post-mortem analysis and found evidence of cyanide poisoning in cadavers. Following a conflict of views over the proper treatment of cyanide intoxication, only in early February the Indian Council of Medical Research issued a guideline for the treatment of injured with sodium thiosulphate.

The precise numbers of dead and injured in Bhopal are uncertain. Immediate victims estimated by the Indian government were about 2000, but raced up to 4000 in 1994. Permanently or totally disabled are 30.000, together with 20.000 temporary cases and about 50.000 minor injured (Lees 1996). At least 7000 animals perished and large-scale environmental damages are incalculable (Prasad and Pandey 1985; reported by Shrivastava 1996).

Beside these evident and somehow "calculable" impacts, others should be accounted in the black list of the consequences of the disaster. Political consequences involved the government of

[152] F. Lees (1996), *op. cit*., Appendix 5/5

India, who engaged in a still unsatisfactory legal battle against the Union Carbide Corporation. The disaster in fact led to various sets of court proceedings, but the management always refused to compare before an Indian court. By its side it shut down the works in Bhopal and promoted an independent investigation over the accident, wherein the hypothesis of sabotage was suggested. Following the reactions of the public and the process before the US court in which the Indian government was involved in litigation, UCC alleged that there were no evidence of this hypothesis.. The Government of India instituted criminal proceedings against UCC, which at the time of writing remained extant. In 1987 UCC made a final agreement for 430 millions of US dollars compensation, against which the victims appealed: the US Supreme Court ruled that they were lacking legal standing to do so (Lees 1996).

Leaving the legal aspects of the controversy apart[153], it is important to stress that the disaster of Bhopal occurred 12 years after Seveso: the resonance of the disaster worldwide was therefore facilitated by the major media coverage at that time. The images of the slums at the border of the establishments, of thousands of poor people with white bandage on their eyes due to the intoxication and of thousands of dead animals reached the entire world. The waves of the disaster (and here, mentioning the pillars of Beck's view appears unavoidable) impacted not only the city of Bhopal together with its inhabitants: the courts before which the then Union Carbide India Ltd faced a controversial and still partially unresolved process are the courts of the whole chemical industry and of the public opinion worldwide[154].

As for Seveso, I would like now to discuss the consequences of the tragedy in terms of its influence on the following developments of the city of Bhopal. As already mentioned, the area has never been decontaminated: Bhopal has known a slightly different destiny than Seveso, where the area contaminated by the accident was converted in a park after the complete clearance of the soil. Nothing similar happened in Bhopal so far: the city remains a symbol of destruction and degradation. Little steps were taken by the government to investigate over the long-term consequences of the leakage and for clearing the areas from remaining pollutant. Union Carbide Corporation by its side didn't promote or took part to any intervention beside the shut down of the plant.

In order to investigate over the residual contaminants polluting the soil and water in the areas affected by the MIC release an investigation *in situ* resulting in a Technical Report was carried out by the Greenpeace Laboratories of the Exeter University in the United Kingdom[155]. In the Report evidence of contaminations of soil and drinking water supply with heavy metals and persistent organic contaminants both within and surrounding the former UCIL formulation plant are documented[156]. The report was endorsed by the Ministry of Chemicals and Fertilizers in Delhi in 2002 and preliminary investigations over the different methods of clean-up were initiated. The

[153] From a legal perspective, the controversy subsequent the accident of Bhopal is certainly complex and raises many issues over the legal standing of ultra-hazardous facilities owned by different companies, run by different managements and finally located in different countries. Two fundamental issues here are the liability of the mother company and, in the particular case of Bhopal, of the jurisdiction applying in case of relevant controversies. For a comprehensive discussion of this aspect of the case of Bhopal see A. Arcuri 2005, *op. cit*.

[154] P. Shrivastava (1996), *op. cit.*

[155] Refer to Labunska *et al* (1999), *The Bhopal Legacy. Toxic Contamination at the Union Carbide factory site, Bhopal, India : 15 years after the Bhopal accident*, Greenpeace Scientific Unit Technical Note 04/99, online. Available at www.greenpeace.to/publications/Bhopal%20Legacy.pdf. Last visited: March 2008

[156] I. Labunska *et al* (1999), *op. cit*., at 4

controversy between the Indian government and Union Carbide Corporation [157] over the responsibilities for the costs of clean-up was at the time not yet resolved.

As mentioned before, the history of the tragedy of Bhopal and its following developments differ from the history of Seveso and, considering the context of the accident, have a unique character. On the other hand the political consequences of the tragedy crossed the Indian borders to reach the entire world. Though 12 years had to pass before the European Union could translate the lesson learned from Bhopal into a new set of regulatory requirements [158], the international resonance of the tragedy is of outstanding evidence. The most relevant lesson learned mentioned by Lees are, among others:

1) Siting of and development and control at major hazard installation: very large number of people were at risk for the establishment in Bhopal. The situation was due in large part to the encroachment of the shanty towns, which came up to the site boundaries. Although these settlements were illegal, the Indian Authorities had acquiesced in them. On the other hand, the accident showed that the plant was close enough to areas populated before the plant processing MIC was built. In case the production of MIC was envisaged from the beginning, the problem should be regarded as a problem of siting; differently, it should be regarded as an intensification of the hazard on site;
2) Information for Authorities and public: the mother company and Union Carbide India Ltd had not provided sufficient information on the substance on site to the Authorities, emergency services, workers and members of the public exposed to the hazard;
3) Planning for emergency: the response to the accident shows that there was no effective emergency plan. The preliminary condition fore emergency planning to protect the public outside the works is provision to the Authorities of full information about the hazards. Due to the lack of such basic information, people did not know how to react when sirens started to spreads the alarm and hospitals did not know neither how to handle the emergency nor which kind of emergency they were facing.

Considering the underdeveloped context of the accident, the lack of basic information over the hazard thousands of people were exposed to and the undersupply of basic infrastructures such as transportation routes, electricity and water supply, it is not surprising that the accident of Bhopal resulted in a tragedy. Nevertheless, concluding that such a catastrophe was entirely due to the particular conditions of a city located in the developing world would be a mistake: other accidents occurred all over the world demonstrated how accidents can indeed being unforeseen disasters.

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[157] Union Carbide Corporation was meantime acquired by the DOW group in 2001 (refer to article of J.F Tremblay "Bhopal Today" in Chemical and Engineering News, online publication of the Indian Institute of Technology of Kanpur. The Author gives an account of the until then developments of the controversy between UCC and the Indian Government together with an overview of the outcomes of he most recent investigations and the actions promoted by organizations such as Amnesty International and Greenpeace International, online. Available at www.iitk.ac.in/che/jpg/C&EN%EN20government.htm . Last visited: March 2008.

[158] As I will discuss in Chapter 2, among such instruments the necessity of accounting the risk of major accidents within long-term land use policies stated in Art. 12 of the Seveso Directive issued in 1996 is certainly among the most important.

2.3 Toulouse: the non-accounted scenario

The accident of Toulouse occurred few days after the terrorist attack to the Twin Towers in New York of the 9th of September 2001. Probably due to the vicinity of the two events, the accident attracted less immediate worldwide attention than otherwise, while it provoked a flood of polemics and renovated the attention for the risks posed by hazardous facilities in France.

The political repercussions of the event were indeed enormous, not only in France but also in the European Union. The accident occurred in a climate of major concern with regard to the risks associated to critical infrastructures, of which dangerous industries are surely a major part. In France, the accident led to a sound revision of the land use planning regulation with regard to at-risk areas and prompted the elaboration of a series of policy and methodological instruments which reshaped the regulatory framework of MA risk prevention entirely. The Law of 30 July concerning the "prevention of technological and natural risks and the repair of damage" is a direct "[…] *result of the national coordination carried out at the end of 2001 following the Toulouse catastrophe* […]"[159]. The Parliament set up a working group and promoted a sound inspection over the causes of the accident, which results were collected in a report which found direct application and mention in the following law[160]. The accident of Toulouse, differently than the previous two and in consideration of the fact that it can be considered the most recent European "lesson learned from accident" will be hence discussed more from the perspective of the repercussions it had on policy-making at national and European level rather than from the technical point of view. A brief account of the dynamic of the accident is anyway reported in the following.

The explosion of (estimated) 390-450 tons of off-specs ammonium nitrate-base fertilizers occurred on the 21st of September 2001 in the AZF fabric of Toulouse. 30 people were killed (21 on site and 9 off site), 2242 injured and damages were reported in an area up to 7 km from the crater left by the detonation. The plant was located in the suburbs on Toulouse, a city of 750000 inhabitants, and was under Seveso regulation for the process and storage of chlorine, ammonia and ammonia-nitrate. The explosion took place in a warehouse located between process parts, storage and packaging areas for ammonia-nitrate. The warehouse had no gas supply, no steam pipes and only natural light, and was managed by three sub-contractors companies, none of which was present at the time of the accident. In the light of these elements investigators have no yet agreed on the origins of the accident: the source of ignition of the stored ammonia-nitrate appears a rather controversial point in consideration of the lack of direct sources within the warehouse. The hypothesis of terrorism and malicious acts were therefore also investigated, without leading to any evidence[161].

The explosion left a crater of 65 x 54 meters in diameter and 7 meters in depth:

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[159] Mnistere de l'Ecologie et du Developpement Durable (2003), *A New Law on Risk Prevention*, online. Available at (http://www.environnement.gouv.fr/infoprat/ . Last Visited: June 2006

[160] Report of the General Inspectorate of the Environment concerning the explosion at the AZF factory (2001), online. Available at (http://www.environnement.gouv.fr/infoprat/Publications/publi-ige.htm).

[161] This detailed description of the accident is provided by Dechy et al (2003), *The Toulouse Disaster and the Changes in Managing Risks Related to Hazardous Plants in France*, Proceedings of the 5th Conference on risk assessment and management in the civil and industrial settlements, 17-19 October 2006, Pisa, Italy

Fig 6 – the crater left by the explosion of ammonium-nitrate at the AZF fabric of Tolouse (from B. Cahen 2006)

According to the detailed account of Dechy *et al*, based on the reports commissioned by the French Authorities in the aftermath of the disaster, the costs of damages were estimated by insurers at 1500 and 2000 millions Euro. 27000 houses were damaged together 17 schools, 26 high-schools and universities in the area. The public transportation company registered 26 millions Euro of losses, together with 1300 companies in the area which were damaged and had to face financial difficulties within the first 6 months after the accident. Mid-term health effects such as severe post-traumatic stress and injuries due to the blast effects interested a total number of 10.000 people.

The Toulouse accident was considered as an alarming signal both in France and the whole Union. Beside the evident lack of safety measures within a warehouse storing a considerable amount of ammonia-nitrate, the siting of the establishment and the urban developments in the surrounding did not account the described scenario (B. Cahen 2006)[162]. The lessons learned from Toulouse reshaped the French approach particularly with regard to this second issue, which found echo also in the European policy debate to the point that an apposite Communication was promptly issued[163].

According to Cahen, several lessons were learned, particularly as far as land use planning was concerned: "[…] *Defense in depth is more than never necessary. However good the risk prevention measures are, maintaining appropriate distances and preparedness in case of accident are key elements* (…)"[164]. The Author lists a number of lessons which can be derived from the accidents, stressing in particular a major need of *prevention* and *reduction* of the risk of accidents by means of:

1. Appropriate design, operation, maintenance and coordination on site. In addition to the technical improvements and the improvements in the reliability of equipment, prevention occurs by better understanding the risk factors in organization and in people behavior (human factor);
2. Emergency plans on and off-site, to be updated and tested on a regular basis;
3. Information to the public should promote a risk-based culture on local level;
4. Land-use planning should maintain or reduce risks over time and deal with historical situations of concern.

[162] B. Cahen (1996), Implementation of new legislative measures on industrial risks prevention and control in urban areas, Journal of Hazardous Materials, Vol. 130 , pp. 293–299
[163] Refer to note 8 of the Introduction.
[164] B. Cahen (1996), *op. cit*., at 295

With respect to the two previously described accidents, though the first dates back to more than 30 years from now and the second occurred in a rather unique and certainly underdeveloped context, the accident of Toulouse reveals surprising similarities. As I will further comment in Chapter 3, where the French regulation for MA risk prevention is investigated in depth, one of the fundamental factor of the disaster was the fact that the scenario was not accounted in the land use planning instruments regulating urban developments in the surrounding of the fabric. Fig 7 illustrates the situation in the surrounding of the plant at the time of the accident:

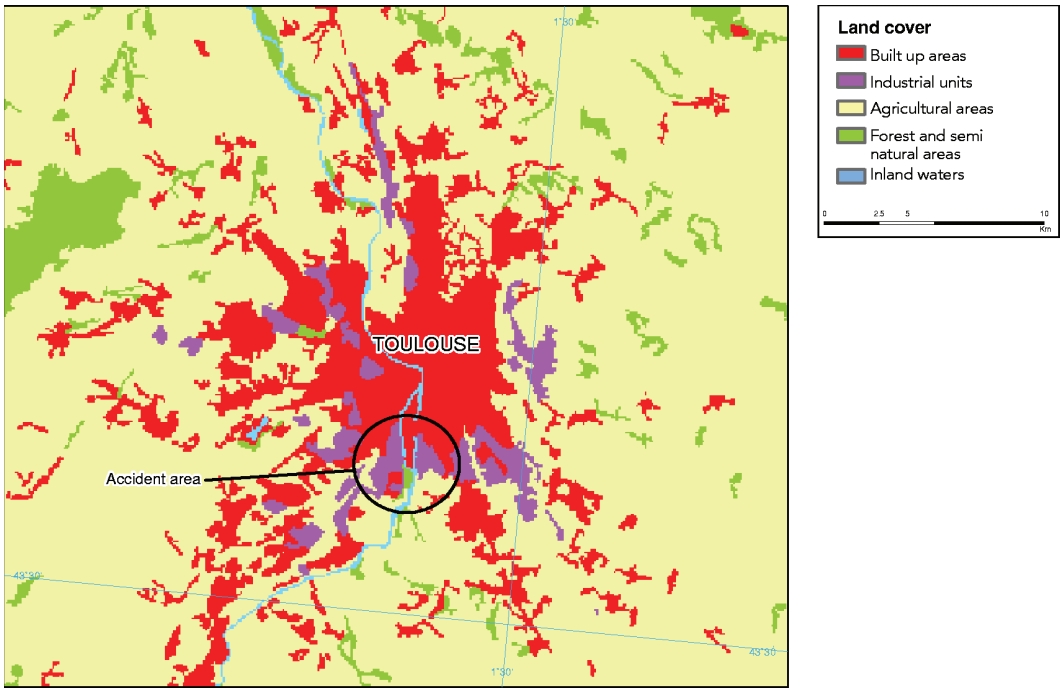

Fig 7 – map of the area surrounding the AZF establishment at the time of the accident of the 21st September 2001 (retrieved from the data-service of the European Environmental Agency, 2008)

As shown in the picture the area of impact of the explosion covered populated areas (in red) together with industrial and environmental areas (in violet and green respectively). The area of impact was exceeding the "control zone" subject to urban restrictions accordingly to the risk posed by hazardous installations: the legislation in place before the new law of July 2003 imposed mandatory restrictions in the areas surrounding Seveso establishment only up to 1 km of distance. Such restrictions were not object of compensation by the side of Operators for plants built before 1989, but only for new establishments, and were therefore rather difficult to implement. The result was that so-called existing situations, which are those situations in which vulnerable areas are strongly interfaced with establishment due to the "un-regulation" of their development along the years, easily escaped restrictions (Salvi 2005, Cahen 2006). This aspect, though with its specific character, is not dissimilar from the lack of land use planning regulation in the surrounding of the ICMESA establishment and from the complete absence of safety-oriented regulation of land uses at the borders of the Union Carbide India Ltd plant in Bhopal.

The matter of accounting accident scenarios in the case of existing situations is certainly the most important lesson the French government translated in the new legislation issued in 2003. Furthermore it is the challenge all Member States are called to resolve in the near future: as explained in the Introduction, urban areas and industry started to be increasingly interfaced at a time in which their proximity was still not object of specific urban requirements: such requirements were issued when most of the at-risk situations were already created, and until urban regulations and safety regulation were somehow "disconnected".

In consideration of this point, after this short overview of major accidents which had a direct influence on the European policy developments and some reflections on the derived *lessons learned*, I will describe a widely used concept, left voluntarily at the end of the case-histories: the concept of *scenario*. As particularly evidenced by the case of Toulouse, accident scenarios are the "instruments" which can "connect" the elaboration of land use and urban plans with the evaluation of the hazard posed by establishments. This last "interpretational instrument" concludes the overview of the main concepts I intended to provide to the Reader for supporting the reading of the book and facilitates the reading of Chapter 2, wherein the developments of the Seveso Directives as lessons learned from accidents are further discussed.

2.4 From case-histories to accident modeling[165]

Even though the practice of scenario modeling is well established in accidents risk analysis, the relevance of the "construction of scenarios" to the elaboration of planning instruments is a relatively new instrument in the context of spatial planning. In the context of this book, an introduction to the relevance of the construction of scenarios to land use planning evaluations is hence appropriate. The section will facilitate the reading in particular of Chapter 4, wherein several European methods for land use planning in Seveso areas are described.

The glossary adopted by the European Working Group on Land Use Planning defines scenarios as "*the set of events which can result in an undesirable outcome*"[166]. As demonstrated by the examined cases, the conditions under which accidents occur and the context in which they develop are fundamental elements for assessing these outcomes. Resolving the equation of probability of hazards is not sufficient for informing land use decisions: other interpretational instruments are necessary.

These instruments can be reassumed as the "credible conditions" under which accidents may occur *and* develop, whereas "conditions" represent both the "internal" technological failure and the "external" reaction of the area which may be involved in the accident. As demonstrated by the analysis performed by Lees, internal conditions observe a cause-consequence relation sequence: major accidents can be followed back in time, as the chain of events (both *causing* and *consequent to*) leading to their occurrence is retraceable in the design *of* and operations *in* the plant as well as in the man-plant interaction. Differently than for other forms of risks, which possible nature and causes are *unknown*, a major accident can be reliably analyzed in terms of the "top event(s)" provoking it and its following developments. Obviously, when the analysis is addressed to the future – it constitutes the *ex-ante* analysis – many different causes are possible. Nevertheless, the

[165] This section is meant to provide non-expert readers with the main interpretational instruments supporting the understanding of the practice of accidents modeling, with a particular focus on their relevance to land use planning evaluations. In so being the section is not a critical analysis of established methodologies but a selection of the aspects most relevant to the practice of land use planning. For a more insightful reading, see C. Kirchsteiger (1998), *op.cit.*

[166] L. Fabbri (200x), *op. cit*.

chain of events consequent to any given cause can be modeled, being the relation among factors (the rupture of a valve and the release of a gas) *certain*.

The modeling of accidents is therefore based on a series of established tools (like the bow-tie, the cause-consequence, the fault-tree and the if-then analysis) based on the assumption that *if* the event A happens, *then* the events B, C etc may follow – all of these events having a certain probability, which can be deducted by the design of the plant and the historical data concerning failures (Christou 1998, Ale 2007). This *if-then* relation among events is what makes the analysis of accidents substantially different than the analysis of other forms of risks, such as climate change for example: the *if-then* relation in the second case connects the infinite numbers of factors of an *irreducibly complex* system (Renn 2005).

In the three examined cases, the interaction between the accidents and their contexts revealed to be a crucial factor for the development of their immediate and long-term consequences. Intuitively, the same accident in all of the three contexts may have led to totally different consequences: the explosion of the AZF fabric in the Bhopal site would have killed more people than it did in France, while the release of MIC in Seveso would have probably affected a considerably lower number of inhabitants. In all cases, the environmental impacts would have been totally site-specific and dependant on the geographical and natural character of the areas. The *ex-ante* analysis of the relation between accidents and their context is therefore essential for modeling their consequences.

These remarks serve to introduce the reader to the concept of *scenario*. Before exploring its relevance to the analysis of the consequences of accidents, I would first recall the definition of "*essence of risk*" as provided by Ale (B.J.M Ale 2007):

> *Fear of harm ought to be proportional not merely to the gravity of the harm, but also to the probability of the event*[167]

This definition brings us back to the "classical" definition of risk as

$$R = P * C \tag{3}$$

This definition epitomizes the "essence" of risk as the probability of consequences associated to a given hazard. Looking at it from the "safety" perspective, this definition implies that not even the most hazardous system or the most dangerous activity are certain to provoke harm or death (B.J.M Ale 2007). By contrast, in consideration of their intrinsic dangerousness, it also implies that such activities are never risk-free.

However, the conditions under which an accident occur and its immediate and long-term developments are difficulty "captured" by the mere essence of risk. One of the original formulations of the concept of scenario was then proposed by Kaplan and Garricks, who reflected on the plausibility of nuclear accidents in consideration of the possible worst-scenario[168]. Recalling a classification of risk provided by Renn, such scenarios belong to the category of Damocles, wherein events have a tremendous disastrous potential but a very low probability.

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[167] M. Arnoud (1662), in B.J.M Ale (2007), *op. cit*., at 12.

[168] As reported by Ale in the part of his book in which the main lines of the concept of "scenarios" as formulated by Kaplan and Garricks are introduced, the worst-scenario related to a nuclear power plant is the ultimate doomsday scenario of the explosion of the whole reactor. Refer to B.J.M Ale (2007), *op. cit*., at 129

Is there a "low" probability "low enough" to question the suitability of these scenarios to become *reference-scenarios* for deciding relevant hazards reduction measures?

In a rigorous deterministic perspective, this question is a non sense: the very fact that certain scenarios are *possible* would be a sufficient condition for deciding to avoid them. In a probabilistic perspective, the reply to the question is more complex. That two airbuses may crash against each other during a transoceanic flight is surely possible, and that this scenario has to be avoided by means of their opportune design and operation, equally obvious. But is the credibility of this scenario *enough* to question the desirability of the technology *tout court*? And: is this event relevant to the design of, for example, the internal disposition of the sits in the cabin? Finally, which are the reference scenarios to be accounted, by contrast, for deciding which safety equipments have to be permanently on board?

As deriving from the previous questions, the scenarios associated to dangerous technologies are theoretically infinite and, for all of them and equally theoretically, a probability of occurrence can be associated. The equation representing the "essence" of risk may be therefore rewritten as in the following[169]:

$$R = f(p\{s\}, c\ \{s\}) \qquad (4)$$

In this formalization, the probability and consequences of risk are derived from the associated scenarios. In consideration of the theoretical infinite number of scenarios, a representative set is usually modeled in order to select the *reference scenario* to be used for evaluating the prevention measures to be put in place for preventing their occurrence. When these measures are enforced through the *non-structural* measures of land use planning instruments (Menoni 2005), the modeling relies on various types of information. The vulnerable objects exposed to risk, the demographic composition of the surrounding population and the predominant wind force and directions during the year are examples of this information. To give an example we may refer to the elementary illustration reported in Fig 8:

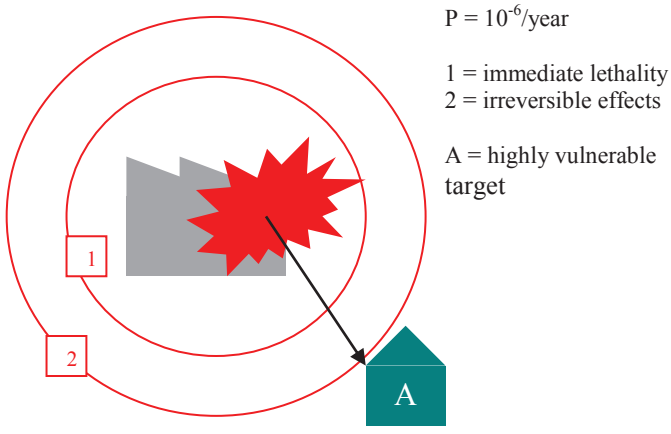

Fig 8 – an elementary representation of major accident scenario analysis

[169] The original formulation of Kaplan and Garricks reads P = f (p, c, s). In this formalization the variable *s* is therefore an independent variable (refer to the B.J.M. Ale, 2007, *op. cit*). In the formalization provided at (4) *s* is instead the dimension from which the probability *p* and the consequences *c* are derived.

Let's assume that the accident illustrated in Fig 8 represents the explosion in the fertilizer fabric occurred in Toulouse. Let's associate to the event the probability of 10^{-6} / year and, for illustrative purposes, let us consider two different iso-effects areas, i.e. two different "rays" within which the effects an individual in normal health condition will be subject to would be the same. These effects are measured calculating the overpressure provoked by the explosion at given distances and are experimentally deducted. Area 1 is where effects are lethal and area 2 is where effects are not lethal but irreversible.

The vulnerable object A is a hospital, i.e. a highly vulnerable object placed in the immediate vicinity of the area of impact. The hospital is however outside the iso-effect area of irreversible consequences and none of the patient of the hospital is exposed to the risk of being affected by relevant effects. It derives that the consequences associated to the event are theoretically 0: no matter the accident occurs, none of the exposed individuals is actually running the risk of being affected by it.

At this point we could increment the number of variables at our disposal. Let's assume that to the explosion a release of a dangerous substance follows. In this case, the predominant wind directions have to be considered and the deriving distribution of the toxic cloud modeled. Let's also assume that the cloud will most probably cover the area where the hospital is located and that the associated effects at that distance are, again, irreversible. In this case, the high vulnerability of the individuals hosted in the building and their difficult evacuation plays a primary role in terms of the effects their may be subject to. In this case, the scenario is more complex than in the first case: more variables come into play, and the resulting risk is obviously higher. A simple calculation of it may be written as

$$R = 10^{-6} * C = 10^{-6} * (Irr_{eff} * V) \quad (5)$$

Whereas V is the maximum level of vulnerability in a given scale, it is reasonable thinking that the irreversible effects on the highly vulnerable guests of the hospital may result in lethal effects. In this case, the resulting individual risk will be of 10^{-6} probability of dying. Let's now assume that the acceptability level established by law equals this value: the hospital lies at "the edge" of the level of acceptable risk. Is the risk to be deemed acceptable?

In order to provide a convincing reply to this question, one possibility is again incrementing the number of variables at our disposal and providing a more detailed picture of the possible dynamic of the event. Let's assume for example that the hospital is provided with high resistance glasses, that the structure is highly resistant to fire and that a prompt evacuation of the building is made possible by a detailed emergency plan, relying on functional evacuation routes. Let's also assume that the dispersion of the toxic cloud according to the estimated amount of the release and the climate conditions in the area will likely occur in a timeframe within which is possible to not evacuate the patients and maintaining them in safety conditions within the building. Let's also assume that the evacuation, by its side, is planned in such a way that its time and conditions will guarantee the safety of the patients as well as personnel of the hospital. In simple words, let's assume that it is possible to decrease the consequences by means of a reduction of vulnerability.

By contrast, let's assume that the emergency plan may not provide a sufficient response to the event due to the particular geographical conditions of the location: the facility and the hospital are placed in a mountain area and limited transportation and evacuation routes are available. Furthermore, the mountains surrounding the area and the high percentage of humidity of the air

limit the capacity of dispersion of the toxic cloud, whose persistence is expected to be longer than in flat areas. Furthermore…

The number of assumptions, variables and considerations which may be added in order to provide a reliable picture of the possible dynamic of the scenario deriving from the accident may be infinite. What has to be stressed is that the triggering event is always the same: it is its development of and the kind of considerations over the acceptability of the associated consequences that constitute the complexity of the decision to be taken for preventing and minimizing them. Furthermore, the evaluation of the "essence" of risk, where consequences are described through a mono-dimensional criterion as in the reported examples, may not be sufficient to inform land use planning decisions. This is discussed in the following section, where some general conclusions are derived.

2.5 Concluding remarks: "essence" and multidimensionality of risk

In this Chapter some reflections on the phenomenon of major accidents derived from three meaningful case-histories were collected. The role of territorial planning for their prevention and the necessity of extending the analysis of accidents to the contexts in which they may occur and develop were introduced. The relevance of the "construction of scenarios" for this purpose was also clarified. By doing so I tried to provide some interpretational instruments for supporting the reading of the following Chapters, wherein the evolution of the Seveso Directives in the light of the mentioned accidents and the different methods adopted by Member States for enforcing the land use planning requirements are described.

As explained in the last section, the necessity of incrementing the number and quality of information for modeling risk scenarios becomes more evident when the risks of concern are of low probability / disastrous impacts (van Breugel 2005, Chichilnisky 2002). The calculation of probabilities associated to technological failures relies on statistical data and accident scenario analysis. When this probability is significantly low, and the credibility of events too questionable for informing decisions, the limits of applicability of the "essence of risk" equation appear in all their evidence (van Breugel 2005). Here, two main reflections have to be addressed: the first regard to interpretation and utilization of "risky numbers" for describing the phenomenon of risk (Arcuri 2005, Slovic 1991) and the second regards the eventual other *dimensions* which can be accounted for informing relevant decisions (van Breugel 2005).

The first issue brings us back to the formalization of the "essence of risk". In the case of major accidents, the consequences of concern are usually expressed in frequentistic terms as the expected number of fatalities per year. This figure corresponds to the so-called *individual* risk (IR). In the majority of European legislations analyzed in Chapter 4, IR is the annual probability that an unprotected, permanently present individual dies due to the exposure to an accident caused by an hazardous installation. This "individual risk figure" is compared with a value, usually set by law, setting the level of *acceptable* risk. The British Advisory Committee on Major Hazards for example sets the level of acceptable risk at 1 per cent of the risk of dying at the age of fourteen in industrialized country due to natural cause. Whereas this "natural" risk is 10^{-4} / year, the acceptable "man-created" risk is set at 10^{-6}/year, which is of one order of magnitude lower than the individual risk of dying by driving in traffic (10^{-5})[170]. The rationale behind is that the acceptable level of involuntarily taken and high consequences risk posed by hazardous technologies should be lower than natural or voluntarily taken risks.

[170] The example is reported by K. van Breugel (2005), *op .cit*. As I will report in Chapter 4, the "10^{-6}" threshold is adopted in the majority of legislations setting a limit for the acceptability of the risk related to dangerous activities. This point will be further discussed in Chapter 4.

The utility of such "risky numbers" for informing risk prevention policies and guiding relevant decisions is of outstanding evidence, as they provide a powerful tool for ranking different safety levels and / or measuring the dangerousness of certain activities. However, are these " numbers" sufficient criterion for determining the decisions relevant to the scope stated in Directives such as the Seveso Directives?

First of all, the very fact that these figures are "measures" implies that they depend on the yardsticks chosen (Arcuri 2005) [171]. For example, the mortality rate in the coal mining industry between the 1950 and 1970 in the United States was measured by Crouch and Wilson according to two criteria: the number of accidental deaths per million tons coaled or thousands of persons employed. In the first case, the mortality risk resulted decreased; in the second case, it resulted increased. As argued by the two Authors, the first index may be satisfactory from a national point of view, whereas the second may result an alarming signal from the labor's union perspective. As extensively argued by Slovic in his analysis of the different criteria used for ranking mortality risks, it is therefore questionable if the reality reflected by "risky numbers" can be a unilateral guidance for risk prevention policies and, in general, the appropriate instrument for characterizing the multidimensionality of risk in society[172].

The individual risk figure poses other limitations. The rationale behind it is that the consequence to be avoided is the death of individuals. Consequences are hence described as mono-dimensional; other forms of losses or disruption of the environmental, social and economical system involved in an accident are excluded from the calculation. As demonstrated by the case-histories reported above, the consequences caused by low probability / high consequences accidents are instead multi-dimensional as they affect the system involved in the accident far beyond the immediate death of the subjects involved.

How to describe these dimensions and how to reflect them in decisional processes accordingly?

One step in this direction was proposed by van Breugel, who introduced the *extended risk* concept[173]. The Author argued on the limits of judging the acceptability of risks against the mono-dimensional concept of the "essence of risk", regardless the consequences are expressed in terms of fatalities, economical losses, etc. The arguments of the Author are primarily ethical: "[…] *whether it is justified to consider a single valued, one dimensional criterion, i.e. fatality rate, as a sufficient criterion for judgment of risk-bearing activities is still a point of debate. Another point of concern is a more ethical point, and it is whether it is justified to take a fatality rate unequal to 0, even if it is a very low value, as an acceptance criterion for risk-bearing activities. The ethical point is that, in essence, people judge themselves qualified to set the price, in terms of a number of fatalities, for the preservation of a certain level of prosperity without giving an answer to the question as to whether the present level of prosperity is justified at all* […]"[174]

In order to overcome the limits of a mono-dimensional criterion van Breugel proposes a multidimensional criterion, in which the single-valued acceptance criterion R is a *sufficient*

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[171] E. Crouch and R. Wilson (1982), *Risk/Benefit Analysis*, Cambridge, Mass: Ballinger, at 12-13. Reported by A. Arcuri, (1995), *op. cit*., at 26.

[172] P. Slovic (1991), "Beyond Numbers: a Broader Perspective in Risk Communication and Risk Perception", in D.G Mayo and D. Hollander (eds.), *Acceptable evidence: Science and values in risk management,* New York: Oxford, at 48-65. The same arguments are variously developed in the article of 1999, Trust, Emotions, Sex, Politics and Science: Surveying the Risk-Assessment Battlefield, Risk Analysis, No.19, 689-701 and in the congress paper of 2002 "Perception of Risk Posed by Extreme Events", presented at the congress *Risk Management strategies in an Uncertain World*, Palisades, New York, April 12-13.

[173] K. van Breugel (2005), *op. cit*.

[174] *Ibid*, at 8

criterion for rejecting an activity, but as *insufficient* criterion for accepting an activity. The extended risk criterion is reported in Fig 9:

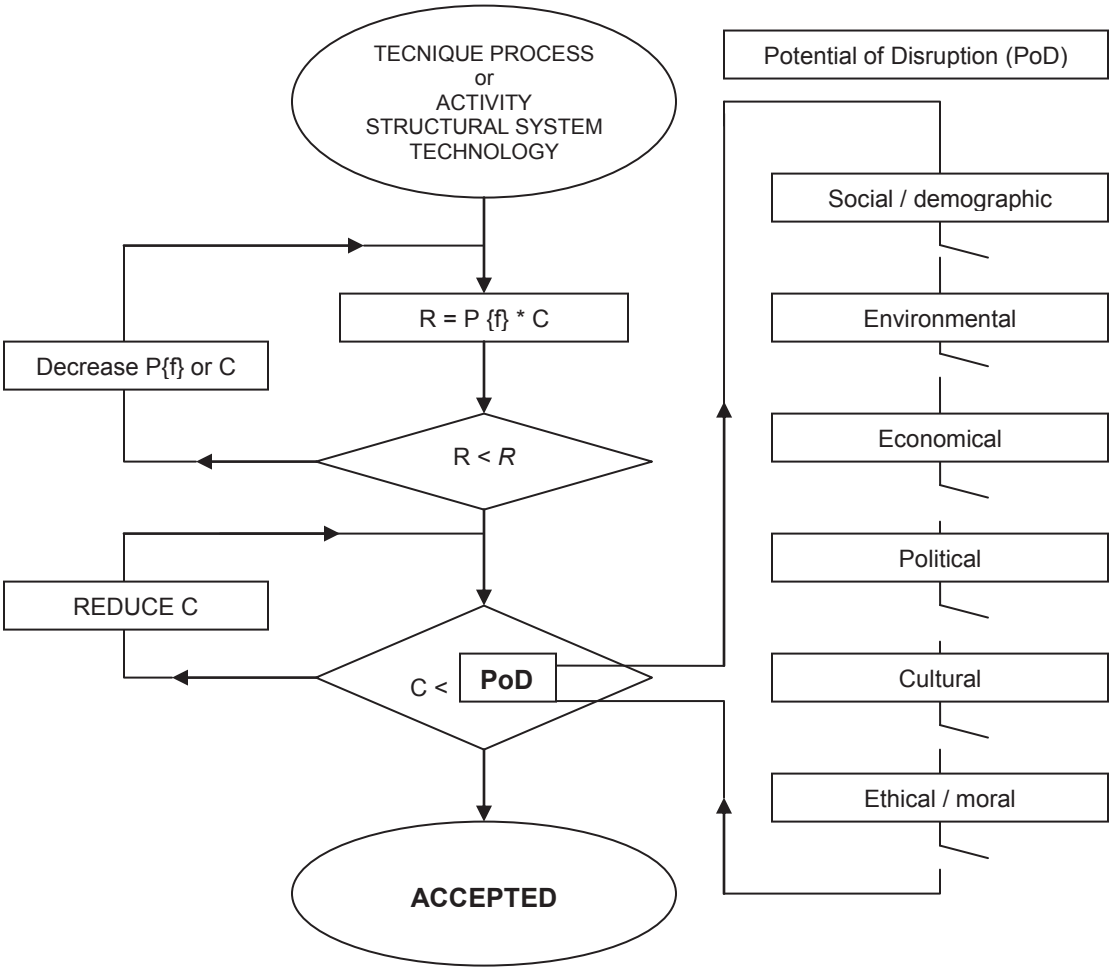

Fig 9 – Extended Risk Concept for Integral Judgment on Low Probability / High Consequences Risks (after van Breugel 2005)

The first part of the diagram corresponds to the "essence of risk" criterion and the decisional process which is usually followed for evaluating the eventual rejection of an activity or process: whereas the risk R does not exceed a given acceptability criterion *R*, there are no sufficient arguments for *rejecting* the activity or process. The second part of the diagram extrapolates the consequences and applies the concept of "potential of disruption" (PoD) to their evaluation. Such disruptions may regard the environmental, demographical, social, ethical or political systems in which the activity or process will take place. The multidimensionality of judgments concerning their disruptions is part of the comprehensive evaluation on the acceptability of the consequences posed by the relevant activity or process. Whereas such consequences may lead to a "disruption" in the diagram, it is questionable whether the activity of process should be accepted in the initial unrevised form.

I would like now to reflect over the different dimensions individualized by the Author and exploring their relevance to the overall process of risk analysis and prevention further. In particular, I would like to reflect on four among them: the social, environmental, political and ethical dimensions of risk.

As reported by the Authors mentioned in the various case-histories reported in this Chapter (Arcuri 2005, Cahen 2006, De Marchi *et al* 1996, Lees 1996, Shrivastava 1996) in their account of the accident of Bhopal, the political consequences of the Union Carbide India Ltd accident impacted the entire world: they were *cross-borders* consequences[175]. Considering the fact that malformed children were born after the accident and that the health effects of MIC persisted for years before leading a considerable number of affected people to death, we may also consider that an intergenerational demographical disruption occurred. Furthermore, a process of *risk amplification* is supposed to have taken place: the whole chemical industry was called to "pay" the consequences of the accident in terms of public image and the whole world was alarmed by the possibilities of such events taking place[176]. The accident of Toulouse, after which the French Government promoted a sound revision of its risk prevention legislation and the European Union re-opened the debate over the matter of the impossibility of "0 risk", has had clear and cross-national political consequences too. In simple terms, local, tangible and catastrophic consequences on humans lead to cross-border, intangible yet serious consequences on humanity.

In the case of Seveso, the most evident "disruption" instead regards the environment. The park realized on the site of the ICMESA plant covers an area which had to be decontaminated from dioxin for 10 years from the accident. The "destiny" of the area where the accident occurred has been, in this way and though with a surely positive result, indelibly marked. The fact that in the aftermath of the accident the then Manager of the establishment was shot dead in a terrorist attack, increasing the shock of a Country already frightened by the wave of "red terrorism" bleeding its streets, should also being accounted among the irreparable social consequences of the event.

Furthermore, the still lively ethical debate over the acceptability of dangerous activities has surely been alimented by these world famous events. This debate led to the sometimes radical oppositions of the environmentalist movement to their siting and, in general, to the awareness of the necessity of a sound re-appraisal of the application of the one-dimensional concept of risk for judging their desirability when this excludes the perceptions and informed acceptance of involved communities.

In summary, none of the consequences associated to these accidents could have passed through the diagram proposed by van Breugel without leading to a disruption in one or more of its parts. Nevertheless it is reasonable to assume that if these consequences were known *before* the accidents, none of them would have occurred: either the probability of accidents would have been decreased, the consequences dramatically reduced or, more likely, both.

In conclusion, a mono-dimensional characterization of risk is a surely powerful tool for ranking different levels of dangerousness and providing a first input to decisions; on the other hand, it is a necessary but not sufficient condition. In this regard, "[…] *we can no longer circumvent the issue of value judgment and, as a consequence of this, the confrontation between different*

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[175] Shrivastava (1996), *op. cit.*

[176] The concept of "risk amplification" was proposed by P. Slovic and refers to the social consequences following the occurrence of major accidents or descovery of new risks with no direct connection to the event or risk of concern. More preisely: "[...] *Through the process of risk amplification, the adverse impacts of such an event sometimes extend far beyond the direct damages to victims and property and may result in massive indirect impacts such as litigation against a company or loss of sales, increased regulation of an industry, and so on* […]" (refer to P. Slovic 2002, *op. cit*., at 12).

worldviews […]"[177]. Accepting the perspective according to which dangerous installations are necessary to social prosperity, it is hence necessary to establish the rules governing their presence. These rules are primarily ethical, and only in second instance regulatory and methodological. This will be discussed in the following Chapter.

[177] K. van Breugel (2005), *op. cit.*, 12

CHAPTER 3

Governing major accidents risk: the European regulatory framework

It is beyond doubt that the capacity to act is the most dangerous
of all human abilities and possibilities, and it also
beyond doubt that the self-created risks
mankind faces today have never been faced before

Hanna Arendt,
Between Past and the Future(1993)

In this Chapter the analysis of the matter of risk of major accidents as regulated in the European regulatory framework is provided and the scope and requirements of the Seveso Directives are analyzed. Following the conclusions of the previous Chapter, the ethical and legal principles which may be used as a guidance for the governance of major accidents risk are discussed. Following the discussion initiated in Chapter 1, the possible role of the precautionary principle and the liability matters associated to the installations of hazardous industries are also discussed. The Chapter proposes an ethical framework which may serve as guidance for the interpretation and further development of the Seveso Directives and provides relevant recommendations.

3.1 Risk and land use planning in the European regulatory framework

The prevention of risks for humans and the environment is a theme attracting major political attention in Europe. Risk connected to chemicals are regulated in a corpus of laws of which the Seveso Directives are only a, though fundamental, part.

The Directives share part of their domain with the Environmental Impact Assessment Directive[178] and have a direct connection with the IPCC (Integrated Pollution Prevention and Control) Directive[179]. The second in particular can be considered as the most relevant to their scope and mandate. Although the main scope of the IPPC Directive is minimizing pollution from various point sources, in Article 3 the Directive requires that "*…installations are operated in such a way that (…) the necessary measures are taken to prevent accidents and limit their consequences".* All installations covered by Annex I of the Directive are required to obtain an authorization from the authorities of Member States and, unless they have a permit, they are not allowed to operate. The permits must be based on the concept of Best Available Techniques (BAT), which is defined in

[178] The complete text of the EIA Directive 85/337/EEC and successive versions can be found at http://europa.eu.int/comm/environment/eia/eia-legalcontext.htm. Last visited: June 2008

[179] Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control. OJ L 257, 10.10.1996, p. 26–40

Article 2 of the Directive and was discussed in the Introduction of this book. However, it should be pointed out that the BAT requirements make only limited reference to safety issues, being the focus of the Directive on pollution.

The Environmental Impact Assessment (EIA) Directive was amended by Directive 2003/35/EC of the European Parliament and of the Council of 26 May 2003. The first version of the Directive dates back to 1985. The EIA has therefore a long history, which development has been enriched, during the last two decades, with the inputs deriving from the communication on the precautionary principle of 1997 together with the Convention of Aarhus on the access to information and public participation to decision-making processes the Commission signed in 1998[180]. The EIA procedure aims at ensuring that the effects of human projects on the environment are identified and assessed before the authorizations to projects are given. In this respect, the Directive adopts the same rationale of the Seveso Directives: the evaluation of impacts *ex-ante* is the criterion for siting installations.

The Directive defines which project categories shall be made subject to an EIA, which procedure shall be followed and the content of the assessments. Next to the *ordinary* impacts of industrial activities, also the *extraordinary* impacts represented by accidents are considered. The EIA requires to Member States to conduct case-by-case assessments procedures and/or to adopt thresholds and criteria for the quantification of consequences. A selection criteria for projects must be, in this sense, "[…] *the risk of accidents, having regard in particular to substances or technologies used*" (selection criteria 1 referred to Art 2). Moreover, the location of projects must be assessed having regard of "[…] *The environmental sensitivity of geographical areas likely to be affected by projects, having regard, in particular, to: 1) the existing land use, 2) the relative abundance, quality and regenerative capacity of natural resources in the area, 3) the absorption capacity of the natural environment*" (selection criteria 2 referred to Art 4). Finally the characteristics of the effects must be considered having regard, in particular, to "[…] *the extent of the impact (geographical area and size of the affected population), the transfrontier nature of the impact, the magnitude and complexity of the impact, the probability of the impact, the duration, frequency and reversibility of the impact*" (selection criteria 3 referred to Art 4).

The concept of risk, vulnerability and the relevance of land use planning in the areas subject to the impacts shape the content and scope of the EIA Directive, which can be regarded as the first in Europe addressing the matter of environmental risk prevention. In several countries, the evident overlap between the Seveso II and EIA procedures led to bring the two regulations together. The documentation required for licensing procedures can be elaborated once.

A third European Directive addressing the matter of risk and bridging its prevention to land-use planning policies is the Strategic Environmental Assessment (SEA)[181]. Its scope is to ensure that environmental consequences of certain plans and programs are identified and assessed during their preparation and before their adoption. The Directive promotes the assessment of the effects on the environment and on human health deriving from the adoption of certain plans and projects in a long-term, intergenerational perspective. A criterion for determining the likely significance of effects referred to in Article 3(5**)** is the preventive assessment of "[…] *the probability, duration, frequency and reversibility of the effects; the cumulative nature of the effects; the transboundary nature of the effects; the risks to human health or the environment (e.g. due to accidents); the magnitude and spatial extent of the effects (geographical area and size of the population likely to*

[180] The text of the Convention of Aarhus can be consulted at http://www.unece.org/env/pp/. Last visited: April 2008.

[181] Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment, OJ 21.7.2001, online. Available at: http://europa.eu.int/comm/environment/eia/sea-support.htm. Last visited: June 2008.

be affected); the value and vulnerability of the area likely to be affected due to: 1) special natural characteristics or cultural heritage, 2)- exceeded environmental quality standards or limit values, 3) intensive land-use; the effects on areas or landscapes which have a recognised national, Community or international protection status". Also here, the typical terminology of risk assessment works as a sub-text. As for the Seveso Directives, criteria and indicators for risk estimation are to be defined by Member States. This relevant presence of the theme of risk in the SEA led, in some National adoption, to an explicit reference to "technological risks" as a main environmental SEA field-of-action[182].

Considering the scope of this book I would like to mention the connections of the described risk regulatory framework with the spatial planning policy promoted by the European Commission, in particular by means of the European Spatial Planning Development Perspective (ESPD) adopted in Potsdam on 10-11 May 1999[183]. The joint document defines the objectives of EU spatial development policy as '[…] *to work towards a balanced and sustainable development of the territory of the European Union. In the Ministers' view, what is important is to ensure that the three fundamental goals of European policy are achieved equally in all the regions of the EU: 1) economic and social cohesion; 2) conservation and management of natural resources; 3) the cultural heritage and 4) more balanced competitiveness of the European territory*". Though the document explicitly refers to natural rather than technological disasters, the topic of risk of soil erosion due to land-uses and of the contaminations of soil and water by pollutants are generally considered. "*Risk factors*" deriving from human as well as natural pressures are also mentioned in the text of the convention. In this respect, the document stresses how "[…] *Knowledge about different risk factors is still insufficient and requires the development of sophisticated methodologies based on a comprehensive concept of risk evaluation*". The Convention also the "[…] *Development of integrated strategies for the protection of cultural heritage which is endangered or decaying, including the development of instruments for assessing risk factors and for managing critical situations"*.

This concise overview of the regulatory framework addressing the matter of preventing the consequences of risks served to highlight the increasing "spatial relevance" of the technological hazards the European territory is subject to. The premises given in this book concerning the territorial dimension of risk prevention appear to be confirmed in the developing European regulation.

3.2 The first Seveso Directive: focusing on information

As argued by Arcuri in her analysis of the development of the Seveso Directives and as often recalled in the course of this book,

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[182] Refer, for example, to the proposal for the Italian Guidelines on the implementation of the SEA procedure issued by the Italian Ministry of Environment in 1999 (Italian: *Linee Guida per la Valutazione Ambientale Strategica*). In this document the matter of technological risks is regarded as a specific "field of action" of the Strategic Environmental Assessment. Available at: http://www2.minambiente.it/sito/pubblicazioni/COLLANA_RSA/suppl9.pdf . Last visited:

[183] *European Spatial Development Perspective – Towards balanced and sustainable development of the territory of the European Union*, Luxembourg, Office for Official Publications of the European Communities, 1999. Refer to: http://europa.eu.int/comm/regional_policy/sources/docoffic/official/reports/pdf/sum_en.pdf . Last visited: April 2008

> "[…] *even if large-scale industrial accidents are not new phenomenon, it is only in the twentieth century that their frequency dramatically increased. (...) By providing a legislative framework for the prevention of major accidents, the Seveso Directives constitute the direct response at European level. (...) Few serious accidents have indeed shaped the development of this body of laws. In particular, the accidents of Seveso and Bhopal have directly stimulated the adoption of the most important Seveso Directives* […]"[184]

In the previous Chapter I provided a description of the causes and consequences of the some representative accidents. The main features and regulatory holes highlighted by these events, with particular regard of their prevention by means of appropriate information and planning instruments, were discussed together with several *lessons learned*.

In this Chapter I would like to analyse the repercussions of the accident on the European legislation and bridging the several lessons learned to the corresponding Directive, the Directive 82/501/EEC[185]. To do so I will refer, beside to the text of the Directive, to the analysis of Arcuri and will recall the studies of Amendola (2001), Christou *et al* (1998, 1999, 2000), De Marchi *et al* (1996), Gowland (1999), Kirchsteiger (1999), Pignatta (2000) and Papazoglou (1998) among others

The Directive was issued 6 years after the accident of Seveso[186] and was further amended in 1987, 1988 and eventually replaced in 1996 by Directive 96/82/EC[187]. The aim of Directive 82/501/EEC (hereafter Directive "Seveso I" or first Seveso Directive) was two-fold: on the one hand it aimed at "*the prevention of major accidents which might result from certain industrial activities*" and, on the other hand, it aimed at "*limiting the consequences of major accidents for the man and the environment*" (art.1).

The scope of the Directive is *de facto* limited to chemical installations as defined in its various annexes (Arcuri 2005). This covered industrial activities involving processes or substances capable to generate, in the case of major accidents, toxic releases, fires or explosions. The substances were defined according to lists of named substances and only to a lesser extent to classes of substances (Amedola 2000). Before analyzing the content of the several Articles of the

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[184] A. Arcuri (2005), *op. cit*., at 204.

[185] See Directive 82/501/EEC in OJ L 230, 1982/08/05, at 1

[186] Concerning this point I would like to recall the summary provided by De Marchi *et al*. with regard to the path for adopting the Seveso Directive. Once the Commission presents a proposal to the Council a consultation with the European Parliament and the Economic and Social Committee must take place before the Council can informally adopt the proposal. A first proposal for the Seveso Directive was presented by the Commission to the Council only in 1979 after a extended consultations among different parties and institutions. The required opinion of the Parliament and the Economical and Social Committee was expressed in 1980 and it took two more years of further consulting and discussion before a Directive was finally adopted on the 24th of June 1982 (refer to De Marchi *et al*, *op. cit*., at 4)

[187] The two amandment to the first Seveso Directive, aimed at broadening its scope, are respectively in Directive 87/216/EEC in OJ L 085, 1987/03/28, at 36 and Directive 88/610/EEC in OJ L 336, 1988/12/07, at 14. De Marchi *et al*. mention how during the revision process which led to the emanation fo the amandment of 1987 there was continuous exchange of correspondance between the Special Bureau for Seveso set up by the Lombardy Region and various institutions of the European Commission. The amandment of 1988 extend the domain of the Directive to more types of storage activities and substantially revised Art 8, stating that information shall be made publicly available as well as actively provided in an appropriate manner. Annex VII was also added and speficied the information which had to be delivered to the public (De Marchi *et al*, *op. cit*., at 7).

Directive more in details, I would like to provide the summary of the principle requirements of the Directive as summarized by Amendola[188]:

1. each Member State shall appoint a Competent Authority (CA) in charge of the implementation of the Directive and its requirements;
2. the Operator shall prove at any time to the CA that major hazards connected with the installation have been identified and adequate safety measures have been taken to prevent accidents;
3. when inventories of dangerous substances exceed specific thresholds, the Operator shall provide the CA with a written safety notification (or safety report), shall prepare on-site emergency plan and shall provide the information needed by the CA for the preparation of off-site emergency plans[189];
4. major modification of the installations shall be communicated to the CA;
5. Member States shall ensure that people liable to be affected by an accident are actively informed of the safety measures and how to behave in the case of an accident;
6. the Operator shall report to the CA major accidents when they occur, and the CA shall further communicate them to the European Commission;
7. the European Commission by its side shall keep a register of accidents so that Member States can benefit from this experience for the purposes of the prevention of future accidents.

The entire Directive is shaped by an *emphasis on information* and aims at promoting an active communication from the Operators to Competent Authorities and from them to the public (Arcuri 2005, Amendola 2000, De Marchi *et al* 1996). Article 8 is a very innovative feature in this regard: for the first time in Europe, the safety of people outside hazardous installations is taken into account and they have to be informed over the risk they're subject to[190]. The Article can be seen as a direct translation of the lesson learned from Seveso, where people and Authorities practically ignored the nature of the hazard they were facing and were consequently unprepared to cope and limit its consequences. Accordingly to the Directive, the flows of information that has to be assured by Member States go mainly in three directions, as exemplified in Fig 10:

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[188] A. Amendola (2000), *op. cit*., at 24

[189] This point is regarded as critical by more parties, especially by environmental protection organizations and NGO's (refer for example to the media note of Greenpeace International over the Seveso Directives and the REACH regulation, online. Available at http://www.greenpeace.org/raw/content/eu-unit/press-centre/policy-papers-briefings/the-seveso-disaster-30-years-o.pdf ; last visited: April 2008). The threshold-based approach of the Directives individualizes essentially two categories of establishments, so-called low-tier and upper-tier establishments. Only the second category, storing more than a certain amount of dangerous substances, is subject to the procedure and obligations following the elaboration of safety reports. The first category is differently regulated also depending to national implementations of the Directives. This implies that to avoid the procedure in place for upper-tier establishments it is theoretically sufficient to keep the amount of substances under the thresholds indicated in the Directives, unless other national provisions are in place. In the mentioned Report of Greenpeace, the proposal of imposing the obligation of substitution for those dangerous substances which can be replaced by other, less harmful chemicals, is stated. Unfortunately I could not find any echo of this proposal in the official sources of information and / or communications of the European Commission.

[190] Accordingly to De Marchi *et al* this Article met a strong resistance and was subject to long delays in implementations (De Marchi 1991, reported by De Marchi *et al*, 1996, *op. cit*.)

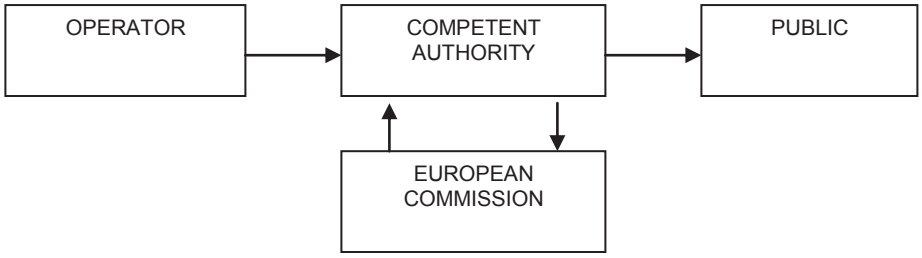

Fig 10 – the flows of information over the risk of major accident promoted by the first Seveso Directive

In addition, as reported at point 7, the Directive mandates the creation of a European register to collect information about accidents and their causes. The register should "*enable Member States to use information for prevention purposes*" (art. 12). In order to encounter this objective, in 1984 the Commission set up the Major Accidents Reporting System (MARS), operated and maintained by the Major Accident Hazard Bureau of the European Commission in Ispra, Italy[191].

According to the analysis of De Marchi *et al*, the institutional effects of the Directive were not confined to the improvements of the management of industrial accidents. Directive 89/391/EEC on the improvement in occupational health and safety and Directive 89/654/EEC addressing minimum health and safety requirements for the workplace are probably to most related to the Seveso Directive. Amendola also underlines the triggering function of the Directive for the emanation of the convention on transboundary effects, discussed by OECD and UN/ECE countries and issued by the European Commission in 1998[192].

As extensively discussed by Walker and agreed by the majority of scholars, the most evident hole left by the first Seveso Directive was anyway the land use planning issue (Walker 1995)[193]. In 1989, hence after the accident of Bhopal, the Commission issued a proposal to introduce a land use planning requirement within those stated in the Seveso Directive[194]. The path from this proposal to the emanation of Directive Seveso II is discussed in the following paragraph.

3.3 The second Seveso Directive and the introduction of Art 12 on the Control of Urbanization

The path from the first Seveso Directive to Directive Seveso II is indelibly marked by the accident of Bhopal occurred in 1984 (Amendola 2000, Arcuri 2005, Christou *et al* 2001, De Marchi *et al* 1996, Walker 1995). Despite the amendments of 1987 and 1988 decreased the thresholds of dangerous substances, extended them to various classes and above all considered

[191] Refer to C. Kirchsteiger (1999), The functioning and Status of the EC's Major Accident Reporting System on Industrial Accidents, Journal of Loss Prevention in the Process Industry, Vol. 12, pp. 29-42.
[192] Convention on the Transboundary effects of Major Accidents, OJ L 362/5, 3.12.98
[193] G. Walker (1995), Land Use Planning, Industrial Hazards and the COMAH Directive, Land Use Policy, Vol. 12, No. 3, pp.197-191.
[194] Council Resolution on Guidelines to Reduce Technological and Natural Hazards 89/C273/01, OJ No O273/1.

their storing as dangerous as their processing[195], the hole left by the lack of provisions regarding land use planning was heavily affecting the efficacy of the Seveso Directive and leaving one fundamental problem of the prevention of accidents unresolved: the proximity between dangers and urbanized areas.

As extensively discussed by Walker, the omission of land use planning requirements in the fist Seveso Directive was acknowledged by the Commission since 1989 in the Council Resolution on Guidelines to reduce technological and natural hazards[196]. The Resolution stated that:

1. Observes that accidents such as Bhopal and Mexico City demonstrated the hazard which arises when dangerous sites and dwellings are close together.

2. Recognizes the importance of controls on land-use planning when new installations are authorized and when urban development takes place around existing installations.

3. Considers it necessary to include this concern among the obligations laid down by Directive 82/501/EEC.

As argued by the Author one of the problematic aspects of Directives such as the EIA and the Seveso Directives is the balance between the Community-wise consistency of the requirements and the flexibility they need to "graft" the deriving provisions within pre-existing legislative and regulatory cultures. The heterogeneity of planning systems and safety cultures throughout Europe can not being overruled by the provision of strict land use planning requirements, such as the prohibition to increase the population density within a given risk contour. On the other hand, the supra-national objective of accounting the risk of MA within land use planning decisions had to be achieved. According to the Author, "[…] *the role of a planning provision within the Seveso Directive should be to ensure that safety is an explicit part of the planning system in each member state, rather than to determine what the outcome of decisions within each of those systems will be* […][197]

The conclusion of the Author corresponds to what Art. 12 of Directive Seveso II[198] would have stated in 1996. The two-fold aim of the regulation (prevention and containment) remains mainly the same, as well as the goal-oriented character of the legislation that imposes some general obligations of prevention on Member States (art.5). Beside this, three mains blocks of provisions have been introduced (Arcuri 2005): rules broadening the scope of the Directive, rules improving the flows of information and, as anticipated, rules linking the safety of ultra-hazardous activities to land use planning.

In short the main innovations introduced by Directive Seveso II can be listed as in the following (Amendola 2001, Arcuri 2005);

- broadening of the scope: the Directive establishes new criteria for the classification of "Seveso" sites. While the Seveso I Directive applied to "industrial installations", the Seveso II applies to "establishments were dangerous substances are present". The dangerousness of an activity is now given by the presence of dangerous substances and not by the type of activity[199];

[195] Here I would like to remind that the accident of Bhopal was caused by a dispersion of hazardous materials from a storage tank, and not as a consequence of a technological failure occurred during the process of the substance.

[196] G. Walker (1991), Land Use Planning and Industrial Hazards. A Role for the European Community, Land Use Policy, Vol.8, No.3, 227-240

[197] G. Walker (1991), *op. cit*., at 237

[198] Council Directive 96/82/EC of 9 December 1996 on the control of major accident hazards involving dangerous substances, OJ L 010, 14/01/1997

[199] This replacement is particularly important. Classifying "Seveso sites" on the basis of the presence of dangerous substances and not the industrial activity is in implicit extension of the scope of the Directive,

- the introduction of Art. 12 on the Control of Urbanization, stating that Member States should take account of the risk of major accidents falling under the definition and requirements of the Directive within their *land use planning policies.* Art. 12 states in fact that land use planning policies should take into account, in the long term, the need to maintain appropriate distances between Seveso establishments and residential areas, particularly sensitive natural areas, etc;
- Related to Art. 12 is the provision of Art. 8 on the so-called *domino effect*, according to which "Member States shall ensure that the competent authority…identifies establishments or groups of establishments where the likelihood and the possibility of consequences of a major accident may be increased because of the location and the proximity of such establishments";
- Finally, the Seveso II strengthens the emphasis on the role played by *information*. According to the classification of low-tier or upper-tier establishment deriving from the quantity of the dangerous substance present in the establishment[200], both falling under the general provisions of the Directive, Operators of upper-tier establishments are required to provide additional information[201].

With regard to the flows of information prompted by the Directive, Arcuri distinguishes four blocks[202]:

1. information produced and supplied by the Operator;
2. information supplied to the public;
3. information supplied by Member States;
4. information that should be produced and circulated by the Commission.

I will now focus on each block with particular regard to the information relevant to the land use planning issue. To do so, I will report the text of Art. 12 introduced before, which reads:

> *Member States shall 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 policies. They shall pursue those objectives through controls on:*
> *(a) the siting of new establishments,*
> *(b) modifications to existing establishments covered by Article 10,*

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whose object becomes the *intrinsic dangerousness* of substances and not the industrial processes in which such substances may be or are involved (Amendola 2001, *op. cit*.)). For eample, brickworks storing large tanks of butane for use as a fuel and water treatment works storing chlorine for water purification, became fully entitled to the classification of "Seveso sites". Hence, the distinction between industrial activities *strictu sensu* and storage facilities fades away for the purpose of the application of the law (Arcuri 2005, *op. cit*.). Furthermore, the concept of establishment endorsed by the Seveso II is relatively broader than the concept of "installation" used in the Seveso I, as it included the whole area falling under the responsibility of Operators. As argued by Wetting *et al*, "[…] this important change of approach removes the loophole where a split of activities and storage facilities into smaller units could allow "escape" from the obligations imposed by the legislation". Refer to Wettig *et al* (1999), Major Industrial Accidents. Regulation in the European Union, Journal of Loss Prevention in the Process Industry, No.12, 19-28.

[200] Refer to Annex I of the Seveso II Directive for the quantifying thresholds.

[201] As pointed out by Arcuri, the general structure of the Articles of the Seveso II Directive is "Member States shall require/ensure that...". Therefore, obligations are addressed to Member States and not to the single actors such as Operators and Authorities. Nevertheless, the provisions for upper-tier establishments concerning additional information are implicitly referring to the obligations of Operators.

[202] A. Arcuri (2005), *op. cit*., at 216

(c) new developments such as transport links, locations frequented by the public and residential areas in the vicinity of existing establishments, where the siting or developments are such as to increase the risk or consequences of a major accident.

Member States shall ensure that their land-use and/or other relevant policies and the procedures for implementing those policies take account of the need, in the long term, to maintain appropriate distances between establishments covered by this Directive 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 and, in the case of existing establishments, of the need for additional technical measures in accordance with Article 5 so as not to increase the risks to people[203]

From the point of view of the flow of information promoted by the Directive in general and Art 12 in particular, it is important to notice that the definition of appropriate distances between hazardous establishments and the mentioned vulnerable targets requires the "visualization" of the hazard and / or risk posed by establishments on a geographical basis and the "mapping" of the surrounding vulnerable objects, both according to given criteria. In this respect, it can be said that the introduction of Art 12 among the provisions of the Seveso Directives required to Member States to produce a flow of information which can be considered, primarily, as *territorial information*.

Information by the Operator

Beside the obligation of providing information over their activities, nature and quantity of substances treated and / or stored within their establishments, Operators shall provide to Authorities a document setting out the major accident prevention policy (MAPP) (art.7). Modifications are also to be communicated (art.10). Should any accident occur, Operators should provide all the necessary information to understand the circumstances, measures taken to mitigate the effects of the accidents and for preventing future ones (art.14).

As mentioned there is additional information to be provided for upper-tier establishments. Art. 9 provides that Operators should produce a Safety Report. Differently than in the Seveso I, the Safety Report should contain proof of the MAPP and proof of the Safety Management System (SMS)[204]. Within the SMS Operators are required to carry out a risk assessment.

As I will extensively discuss in Chapter 3, Safety Reports play a pivotal both for the implementation of the requirements of the Seveso II and for the elaboration of land use planning instruments. Such documents reflect in fact the various national implementations of the Seveso II Directive while acting as a first "source of information" for the elaboration of emergency and land use plans by the side of Authorities. Operators of upper-tier establishments should in fact elaborate an *internal emergency plan*, communicating it to Authorities and providing them the information necessary for the elaboration of *external emergency plans*. In some countries, Safety Reports

[203] Refer to the text of Directive Seveso II.

[204] As reported by Mitchinson and Papadakis (1999), "[…] *the simplest reason why an SMS is required under the new Directive is the large proportion of accidents reported in the European Commission MARS system since 1984 for which failings are underlying causes* […]" (see N. Mitchinson and G.A. Papadakis, Safety Management System under Seveso II: Implementation and Assessment", Journal of Loss Prevention in the Process Industry, No.12, 43-51.

should also contain evaluations over the compatibility between the risk posed by the establishment and vulnerable objects located in the surrounding[205].

In short, the information contained in the Safety Report are essential for complying with the requirements stated in the Seveso II Directive. In this regard the responsibility of Operators is surely increased with respect to the first Directive.

Information to the public

As seen in the reported case-histories, the role of information before, during and after the development of accidents is crucial in terms of prevention and minimization of their consequences. Among the information which have to be supplied to the public, and more specifically the persons liable to be affected by accidents, those regarding the safety measures and the required behavior in case of accidents are the most important. For upper-tier establishments such information should be *actively* supplied (art.13, indents 1, 4 and 6)[206]; nevertheless the Directive doesn't specify the way this information should be supplied and the parties which should supply them.

Furthermore the public should be *consulted* in the case of new installations, modification of existing establishments, developments in their surroundings (art. 13 indent 5) and for external emergency plans (art 11, indent 3). It is important to stress the different meaning of *information* and *consultation* in this context, being the first a one-way flow of communication and the second a communication subject to a "feedback" by the side of third-parties. As I will report in Chapter 3, in the context of Art 12 this feedback is usually represented by the process of consultation, established in the majority of Member States, with regard to the adoption of planning instruments, with particular regard of municipal plans. Being such planning instruments the instruments within which the siting of dangerous establishments and the land use planning in their surrounding is usually regulated, they also become the instrument by means of which the public is consulted about the risk they are subject to. In this regard, it is important to notice again how the flow of information enhanced by the Directive Seveso II, in general, and Art 12 in particular, is primarily a flow of *territorial information.*

Information by Member States

The Seveso II Directive requires to Member States to provide information respectively to Member States (art 13)[207] *and* the Commission. In the first case, the requirement refers to the case of possible transboundary effects of major accidents; in the second case, the requirement refers to

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[205] See for example the Italian Decree implementing the Seveso II Directive, DLgs 334/99 and the Decree 9 May 2001 on urban requirements for areas subject to major accidents risks. For a complete reference of the two laws and their discussion refer to Chapter 3.

[206] Though the Seveso II Directives doesn't specify how *actively* should be translated in practice, the most conventional interpretation is that information should be supplied regardless their eventual request from the side of the public, which should be involved in the information process by means of unilateral actions by the side of Authorities. In this regard the obligation seems to comply with the "right-to-know" principle (De Marchi *et al* 1996, *op. cit*.), though the obligations leaves an ample margin of freedom to Member States. Nevertheless, as I will discuss in Chapter 4 and further in Chapter 5, the "right-to-know" is differently interpreted by Member States.

[207] The article is the only article of the Directive implicitly referring to the case of *interstate externalities*. Notably, the fact that the Directive doesn't impose a standardized method for the regulation of such externalities in terms of the prevention of consequences of accidents by means of equal land use planning criteria implies that the two or more countries "sharing" such externalities have the only obligation of disclosing relevant information. Nevertheless, the circumstance of interstate externality can be seen as one of the element in support of the desirability of Directives such as the Seveso and as one of the elements more consistent with the subsidiarity of their mandate.

the occurrence of accidents, which should be reported to the Commission according to the criteria listed in Annex IV of the Directive (Kirchsteiger 1999). Member States should also communicate the results of their analysis with respect to the causes of such accidents (art 15, indent 2). The article also prescribes that "[…] Member States shall inform the Commission of the name and address of any body which might have relevant information on major accidents and which is able to advise the competent authorities of other Member States which have to intervene in the event of such an accident".

Information by the Commission

Finally, the Commission has the duty to establish and keeping a register and information system at disposal of Member States (art 19). This system is the MARS system, which was already established in response of the first Directive. As reported by Kirchsteiger, the fact that the criteria for reporting accidents have meantime changed and that Member States became more acquainted with the reporting activity increased the number of reported accidents in the last years (Kirchsteiger 1999).

3.3.1 Challenges associated with the introduction of Art 12: some remarks

As outlined in the previous sections, the introduction of Art 12 on the Control of Urbanization within the corpus of requirements of the Seveso II Directive employed a long period of time for being formulated, precisely 14 years after the emanation of Directive Seveso I. As mentioned before, one of the issue which can be related to this "delay" is the friction between the object of the provision, the subsidiarity mandate of European law and the heterogeneity of approaches for dealing with the land use planning issue developed in European countries until then.

Art 12 states an objective which extends the domain of the Seveso Directives to the land use planning policies of Member States, which as well known are strictly related to the national specificities of European countries and strongly dependant on their legislative as well as socio-demographical contexts. Though Art 12 states an objective without providing any mandatory method for its achievement, it may be hence questioned whether its scope is consistent with the subsidiarity mandate of European law rather than falling under the legislative competence of Member Sates.

As already mentioned this issue has been debated in literature (Christou *et al* 1999, Walker 1998). The majority of Authors agreed on the interpretation of the scope of Art 12 as the provision of an objective, necessary to complete the provisions complying with the general scope of the Seveso Directives, which doesn't and should not involve the imposition of a standard equally applicable to all Member States. The latter shall in fact *ensure* that the scope of preventing and minimizing the consequences of MA is accounted within land use planning policies and the procedures implementing such policies: hence Art 12 states *de facto* a policy objective rather than requiring the enforcement of pre-defined measures.

A second problematic aspect of the introduction of Art 12, which could also partially explain the delay of its introduction within the corpus of provisions of the Seveso Directives, is the matter of existing situations. Notably, Art 12 applies to new establishments, their modification or new developments in their surroundings. It hence doesn't explicitly address the matter of existing situations in which Seveso establishments pose an (eventually unacceptable) risk to the surrounding areas. This matter falls *de facto* under the legislative competence of Member States, having the Seveso Directives no retroactive effect and being the issue of existing "Seveso situations" excluded from their domain. The only indication of Art 12 in regard is providing existing situations with *additional technical measures* (ATM) so to not increase the risk for population.

In consideration of the lack, in some European countries, of specific land use planning regulations addressing the matter of Seveso establishments before the emanation of the Seveso II Directive and in consideration of the relatively recent classification of establishments according to the amount of substances provided by its Annexes, existing situations are reasonably expected to represent a majority of cases. The matter of the non-retroactivity of Art 12 and generally of non-retroactivity of the land use planning regulations preventing the consequences of major accidents has been limitedly treated in literature (Cahen 2006). Whereas residential areas have been permitted (and, implicitly, property rights granted) in the immediate proximity of Seveso establishments, the non-retroactivity of new land use planning regulations represent a clear inefficiency in terms of the prevention of the consequences of accidents. Here, other measures should therefore find application, like the possibility of imposing the adoption of additional safety measures to Operators by the side of Authorities (the objective being decreasing the risk at source) or providing additional protection measures to the resident population (the objective being decreasing the exposure of targets). Eventually, legal measures such as the expropriation of existing properties could find application in all cases in which alternative measures are not feasible. Though this measure could be seen as the *extrema ratio* among the possible set of decisions, it is important to mention that it is part of provisions introduced by one of the most recent European regulations implementing Art 12, namely the new French law of 2003 which was derived from the lessons learned from the accident of Toulouse.

From the methodological perspective, the implementation of Art 12 has been appropriately defined as the construction of a "methodological bridge" between two independent disciplines, namely risk analysis and land use planning[208]: "[…] *the deterministic nature of the urbanism practice, finalized to the territorial regulation of land uses, encounters some difficulties in dialoguing with the practice of risk analysis, which is essentially based on probabilistic considerations*"[209] (emphasis added). This remark is relevant to a considerable part of the analysis which will be developed in the course of this book, as it stigmatizes the core of the problem associated with the prevention of major accidents from a territorial perspective: the problem of translating, into a territorial distance, the prevention of an event characterized by uncertainty. In consideration of the fact that the ultimate scope of the planning practice is allocating and balancing the functions of the limited resource represented by the territory, it is easily derivable that the "measure" of this distance has to be balanced against land scarcity. Here, the problem of defining "*how safe is safe enough*?" can be rephrased as "*how far is far enough?"*.

In consideration of the heterogeneity of methods applicable to the resolution of this question and the impossibility of providing univocal responses at European level, the European Commission provided Member States with a series of additional instruments supporting the implementation of Art 12, namely the Guidance and the *Roadmaps* which were mentioned in the Introduction of this book. The literature over these two supporting documents is particularly scarce, being their adoption by the side of the Commission very recent and the context of their elaboration regulatory rather than scientific. Although their declared scope is supporting Member States in implementing Art 12 according to agreed principles and objectives and not providing additional mandatory requirements, the analysis of these documents in the context of this book is consistent with the objective of providing an extensive overview of the European regulatory framework

[208] As I will remember also in Chapter 4, the definition of "methodological bridge" was mentioned by one of the presenters, namely Dr. G. Fontana, during a seminar hold p/o the Italian Ministry of Infrastructures and Transport on the Italian Decree implementing Art. 12 I followed in 2002. Unfortunately I could not recollect relevant proceedings and I can therefore not provide a detailed reference for such definition.

[209] Italian Ministry of Infrastructures and Transport (eds), *Territorial Planning and Technological Risk* (Italian: *Pianificazione del Territorio e Rischio Technologico*), CELID, Turin, 2002; at 15

governing the risk of major accidents and the main problematic issues related to this objective as discussed in the European political arena. Their brief descriptions are therefore reported in the following paragraphs.

3.3.2 Implementing Art 12: the guiding principles provided in the Guidance adopted by the European Commission in 2006

The document *Land Use Planning Guidelines in the context of Article 12 of the Seveso II Directive 96/82/EC as amended by Directive 105/2003/EC*[210] is fruit of the cooperation among the members of the European Working Group on Land Use Planning (EWGLUP), appointed following the first amendment of Directive Seveso II and coordinated by the Major Accidents Hazard Bureau of the Joint Research Centre of the European Commission[211]. The document is presented in the Executive Summary as "*existing best practice drawn from the cumulative knowledge of experts in this field*"[212] and "*is intended to give guidance for risk assessment in Land Use Planning (LUP) in general as far as the major accident potential of industrial establishments is concerned. The main aim in this respect was to combine the understanding of the land use planners and the risk assessment experts in a coherent view. In this respect it may offer especially land use planners not familiar with industrial risk assessment considerations a quick and comprehensive information resource*"[213].

The declared purpose of the document of bridging the knowledge and expertise of planners and risk analysts is its most interesting aspect, being the literature over this issue of particular scarcity and the composition of the European Working Group a good mirror of the heterogeneity of professionals and authorities involved in the implementation of Art 12 in Member States. Though the analysis of this supporting policy instrument has to be limited to some qualitative considerations, being the document not a scientific but a policy-oriented piece of work resulting from the efforts of a cross-sector working group, as a matter of fact the Guidelines are the only European document addressing the matter of land use planning in the context of the Seveso II Directive explicitly and it is the only one mirroring the problematic issues related to the implementation of Art 12 in a comprehensive work. In this paragraph I will therefore highlight the main elements collected in the document and I will argue on those among them which are more consistent with the scope of this book.

First of all it is interesting reporting the definition of land use planning as given in Guidance, namely "*a systematic assessment of land and water potential, alternative patterns of land use and other physical, social and economic conditions, for the purpose of selecting and adopting land-use options which are most beneficial to land users without degrading the resources or the environment, together with the selection and implementation of measures most likely to encourage such land uses"*[214]. Land use planning is further explained "[…] *an aspect of spatial planning, a term that refers to the "space" as a multidimensional concept that describes and*

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[210] M. Christou and T. Biermann (eds.), *op. cit*., 2006.

[211] A previous Guidance was issued by Christou and Porter in 1999 under the title *Guidance on Land Use Planning as required by Council Directive 96/82/EC,* JRC Technical Report, Ispra. The current Guidance was required by the first amendment of the Seveso II Directives and comprises a d-base of accidents scenarios to support Member States in their land use planning evaluations (Art.7 (b), 1a. See Council Directive 2003/105/EC, *op. cit*. at 3

[212] *Ibid*, at 3

[213] *Ibid*, at 3

[214] M. Christou and T. Biermann (2006), *op. cit*., at 8; the definition of land use planning is taken from FAO, *Guidelines for land-use planning*, FAO Development Series No. 1, Rome 2006.

reflects the synthesis of the physical environment and its use by humans […]"[215]. Finally, spatial planning is defined as *"*[…] *the methods used by the public sector to influence the future distribution of activities in a space or spaces. It is undertaken with the aim of creating more rational territorial organization of land uses and linkages between them to balance demands for development with the need to protect the environment and to achieve social and economic objectives. Spatial planning embraces measures to co-ordinate the spatial impacts of other sectoral policies to achieve more even distribution of economic development between regions than would otherwise be created by market forces and to regulate the conversion of land and property uses* […]"[216]. The Guidance furthermore specifies as "[…] *although spatial planning is now widely used as a generic term for all systems, the systems have considerable differences. Each country has a specific name for its system of planning, for example, urbanisme et aménagement du territoire (France, Belgium, Luxembourg), town and country planning (United Kingdom), Raumplanung (Germany), ruimtelijke ordening (the Netherlands), fysisk planering (Sweden), land use planning (Ireland). The meaning of these terms has evolved in the particular legal, socio-economic, political and cultural conditions of the country or region in question.* […]*"*[217].

As to be expected in a European Guidance, the given definitions of land use planning and spatial planning reflect the generalities of both terms and recall those already adopted within previous European documents. The same approach is used for providing the definitions of risk, risk assessment, risk analysis, etc.

An interesting part of the Guidance is the one addressing the problem of major accidents risk prevention in the context of land use planning; here the Guidance alleges how: "[…] *the role of land use or spatial planning in risk management depends on its scope according to national legislation. In the traditional form of land use planning, LUP mainly would be a mitigation tool to reduce the extent of consequences, but in connection with a permit scheme and the possible imposing of technical conditions it is also a prevention tool* […]"[218]. The role of planning is therefore acknowledged as a *preventive*, and not only a *mitigation* tool. In consideration of the fact that the Guidance has the declared scope of providing an overview of agreed best-practice principles for performing land use planning consistently with mitigation *and* preventive purposes, the core of the document is represented by the provision of the a series of principles for "a proper land use planning", namely[219]:

- clear definition and assignment of roles and responsibilities including appropriate institutional framework and administrative structures,
- availability and accessibility of data and information,
- participation of all stakeholders,
- simplicity and clarity,
- realistic concepts in terms of scope and implementation, and
- assessment of impacts.

Here the Guidance appears to provide only general principles, applicable to the ordinary practice of land use planning beside the specific matter of major accidents risk; in the following,

[215] *Ibid*, at 8
[216] *Ibid*, at 8; the definition of spatial planning is taken from European Commission, *EU compendium on spatial planning systems and policies,* Brussels 1997.
[217] *Ibid*, at 8
[218] *Ibid*, at 12
[219] Ibid, at 14

the Guidance provides the definition of best-practice in the context of risk assessment, of which I selected the most relevant[220]:

- Definition of scope, objectives and risk criteria,
- Description of the object or area of concern,
- Identification of hazards,
- Identification of vulnerable targets,
- Development of escalation scenarios,
- Estimation of consequences,
- Estimation of likelihood,
- Presentation of resulting risk and comparison with established tolerability criteria,
- Identification of mitigation measures,
- A level of detail proportional to the severity of consequences, and
- Transparency of the process.

By providing the listed best-practice principles in the context of land use planning and risk assessment, the Guidance has probably the underlying scope of highlighting the principles common to the two practices and providing an overview of those among them which may result from their integration. This assumption is confirmed by the following Table, in which the various principles named so far are combined and explained in terms of their relevance to the practice of land use planning in the context of major accidents risk:

Table 4 – principles of best-practice in the context of land use planning and major accidents risk (from Christou and Biermann 2006)

General Principles	Explanations	Outcomes & Comments
Consistency		
Hazard/Risk Assessment methods should exist	Risk assessment can be based on hazard and/or risk; generic adoptions may be used	A systematic approach to LUP advice will be used
Inputs should include a representative set of major accident scenarios	A credible and/or evaluated range of scenarios should be defined to provide information on the potential extent of consequences	Distances or zones are determined within which LUP controls should apply
Planning decisions should be broadly similar	In similar situations for similar hazard or risk conditions the planning decisions reached should be broadly similar	Avoidance of undesirable development and promotion of activity which meets socio-economic requirements
Proportionality (also: reasonableness)		
Criteria exist for desirable limits or boundaries of the level of harm and risk control requirements	Support decision making on land use development by providing comparative measures, analyzing them and justifying	Subjectivity in decision making is reduced
Development types are characterized	Types of land use in the vicinity of MA establishments and their population to be established	Optimisation of land use.
Judgment frameworks are described	A set of benchmarks is provided within which decision makers can exercise their discretion	Land Use Planning is determined having regard to public safety as well as socio-economic considerations

[220] Ibid, at 15; the principles of best practice in risk assessment are taken from Lees (2006), *Loss Prevention in the Process Industry*, *op. cit*.

Transparency		
An understandable, clear and well-described system exists	A coherent explanation of the LUP system is possible/assured for all interested people/persons	The LUP system is practicable in all parts of the State Member
Responsibilities for key actors are described	All key actors know their role and the limits within which they exercise their responsibilities	Everybody within the system knows what to do and the limits of his or her discretion
Mechanisms for independent control exist	Land use decisions must be coherent with regional and national policies	Potential undesirable land use decisions are subject to review and may be prevented
Decisions can be understood at the time they are made and later.	Decision factors are laid down and the decision-making process can be retraced and decisions are recorded	Decision flow is made transparent and can be reproduced

With specific regard to the obligations stated in Art 12, the Guidance provides further additional principles, reported in Table 5:

Table 5 – supporting principles of best-practice for complying with the specific obligations stated in Art 12 (from Christou and Biermann 2006)

Supporting Principle	Explanation	Outcomes & Comments
LUP process has a role in the prevention and mitigation of major accident hazards over time.	Can be up to 30 years to achieve its impact (50 years in cases of large scale strategic planning)	Not always immediate effect of LUP for the consequences of a major accident (MA)
Risks to public should not increase significantly and over time be maintained or reduced where necessary	MS need to develop approaches to define what is “significant” (baseline)	Risk communication may be necessary
The residual risks arising from a Major Hazard (MH) establishment to individuals and to society should not exceed a maximum desirable level.	- Residual risk is the risk that remains after having relevant safety measures in place. - MS need to establish approaches to define desirable levels	There must be LUP-related policies that mitigate the risk. . These LUP policies should be such that can be implemented and able to reduce off-site risk at all times
Manage population/community development over long term	Long term strategic planning of the use of land in the vicinity of a MH establishment	- Authorities must define the area around Seveso establishments where safety issues have to be considered; - balance land use to control public risk where necessary
Equity balance should be achieved between major hazard establishment operators and community	Operators and community should share the constraints, benefits, opportunities, etc.	Possible need for further proportionate measures on-site or off-site (includes design and lay-out of the planned development)
Mitigation can be achieved through LUP in combination with emergency planning	LUP should have a stronger influence in mitigation near to the establishment compared to emergency plans (e.g. in case of risks from explosions)	- Necessary cooperation of LUP and emergency planning and mutual consideration - Possibly different scenarios for LUP and emergency planning.
Public safety and socio-economic considerations are both significant factors, the	- Risks do not have a zero value but usually diminish with distance - Some development should be allowed near to MA establishments	- Proper proportionality will be achieved - Different patterns of land use are possible

balance of which may change with distance	provided the risks are at a desirably low level.	
LUP considerations that prevent or mitigate the con-sequences of MA should be given more weight in choosing the location of a new MH establishment.	"New" means "green-field" or new because of change of operation to bring into the Seveso II Directive. New MH installations should be considered undesirable where developments which would be considered incompatible already exist.	MS authorities should seek to achieve appropriate distances from those areas listed in Article 12.

A first inevitable comment on the best-practice principles reported in the two tables is their broad generality, and their resulting applicability to the different legislative and operational contexts shaping the European Union. In this respect, it may be argued that the Guidance fails in providing a set of more practical instruments supporting the understanding and implementation of Art 12, and that it limits its contribution to the confirmation of the "pillars" already provided by the Seveso II Directive.

The document continues by providing a set of best-practice principles for the different cases of assessment covered by Art 12, namely those related to existing Seveso establishment and the additional technical measures, and by providing an overview of the several risk assessment methods developed in Europe as derived from literature and a direct investigation of Member States policies. The risk-based and the consequence-based methods are those described more in details. Here, the Guidance appears to confirm the outcomes foresaw by Gowland already in 1999, when in his article over the expected outcomes of the several Working Groups established by the European Commission for providing harmonized approaches for complying with the several requirements of Directive Seveso II he wrote : "[…](In the context of Art 12) *The possibility of harmonisation of methodology and decision making seems extremely remote since there is no common ground on risk management methods. The most obvious divergence is between the deterministic and probabilistic approaches*. (…) *A minority of states has no discernable policy relating to 'hazardous' industrial development beyond the concept of nuisance. They would be greatly helped in the unlikely event of harmonisation. The outcome is most likely to be a 'shopping list' of possible policies from which these states could choose. The others could politely ignore this list because their policies already work well for them and the industry understands and accepts them* […]"[221].

This remark confirms the "character" of the document – which is essentially the provision of general principles which are meant, on the one hand, for harmonizing national approaches to a level of generality which cannot conflict with any of the legislative backgrounds of Member States and, on the other one, for providing a set of policy options which can be used as references for formulating National regulations. Although this generality is consistent with the non-mandatory mandate of the Guidance and its derivation from the joint effort of a cross-sector working group representing the various professionals and authorities in charge of the implementation of Art 12 at national levels, little room for critical analysis remains: the principles of best-practice and the "shopping list" of methodologies are a detailed, and valuable, review of established national practices and recent literature[222].

[221] R. Gowland (1999), *op. cit*., at 20

[222] These parts of the Guidance are mirrored in the supporting document Roadmaps, from which the primary information for elaborating the country-profiles reported in Chapter 3 are derived. In order to avoid repetitions, these parts of the Guidance and the document *Roadmaps* are discussed and used as references in Chapter 3.

As explained before, this point is where the JRC investigation finished and the analysis collected in this book started. Is there a rigorous way to explain the different approaches developed in the Union? If so, which are the limits and horizons of a joint European regulation? this will be discussed in Chpater 4. In the following, the discussion initiated in Chapter 2 over the ethical issues related to the siting and acceptance of dangerous establishments are discussed.

3.4 The acceptability matter. Some ethical considerations about the siting of hazardous facilities

Having introduced the main key-of-readings of the matter of major accidents risk and having provided an insight of the European regulatory framework relevant to major accidents risk prevention I would like to address some ethical consideration. My intention is providing the Reader with the theoretical instruments which may support a more critical understanding of the Seveso Directives and concluding the discussion initiated in the previous Chapter.

In first instance I will recall the work of Ersdal and Aven (2008)[223] and their analysis of the main ethical theories applicable to risk prevention. The interesting work of Smith over the relation between environmental risk and ethical responsibility as deriving from the comparison of the visions of Beck and Arendt will serve to conclude some of the initiated reflections over the paradigm of risk society (Smith 2006)[224]. Finally, the work of Peterson and Hansson over the residual moral obligations associated to siting controversies[225] and the analysis of Moroni of the "ethics of territorial planning"[226] will conclude the discussion over the ethical principles which may serve to provide a framework for the regulation of major accidents risk from a territorial perspective.

As before discussed, risk prevention is about deciding in conditions of uncertainty. Uncertainty in this context was expressed as the inherent *unpredictability* of unwanted events, which results from the limits of *ex-ante* accidents modeling. In front of this unpredictability and considering the different decisions which may conduct to the "non-dynamic event" of safety (Weick 2001), it is legitimate to wonder which among them is the "good" decision[227]. For example, one could question the ethics of applying the ALARP principle for the prevention of accidents because of the residual risks threatening society, or could question the "moral basis" justifying the use of cost-benefit-analysis for deciding the siting of a polluting fabric despite the exclusion of the non-monetary aspects of each alternative.

These questions are addressed in philosophy as questions of moral and norms (Ersdal and Aven 2008). The two main theoretical directions along which their discussion can be developed are *deontology* and *consequentalism*. The formulation of the first question reported in the first example will differ depending on the application of one of the two perspectives. In the first case, the question would be "*has ALARP to be accepted*?", whereas in the second case it would be "*considering the consequences of the application of ALARP, has the principle to be accepted*?" In the first case the question is whether permitting of banning the use of the principle *tout court*, whereas in the second its "goodness" is assessed against its consequences. The rationale behind in

[223] G. Ersdal and T. Aven (2008), *op. cit*.
[224] M. Smith (2006), Environmental Risks and Ethical Responsibilities: Arendt, Beck and the Politics of Acting Into Nature, Environmental Ethic, Vol.28, No.3, 227-246
[225] M. Petterson and S.O. Hansson (2004), On the Application of Right-Based Moral Theories to Siting Controversies, Journal of Risk Research, Vol. 7, No.2, pp.269-275
[226] S. Moroni (1997), *Etica e Territorio*, (English: *Ethic and Territory*), FrancoAngeli, Milano.
[227] The term "good" is here used in its moral connotation.

the first case is that actions are *per se* good or bad, whereas in the second case actions are good *depending on their consequences*.

The *corpus* of deontological theories has its pillars in the seminal works of Immanuel Kant, who established the still influential distinction between the *cognitive* and the *moral* interests of reason (Ersdal and Aven 2008). Among the scholars who applied such distinction and developed the reflection over "the human condition" further, I will recall the thought of Hannah Arendt and her fundamental contributions to the promotion of a social debate on science[228]. Among the developers of the consequentalist theories, a privileged mention is deserved by the exponents of the utilitarian current, resting on the foundations established by John Stuart Mill and Jeremy Bentham theories[229].

Based on the assumption that certain actions are intrinsically and always wrong, deontology is the doctrine of *permission* and *prohibition* (famous in regard is the radical position of Kant for whom lying is always wrong, no matter a murderer is asking for the location of a victim)[230]. Based on the assumption that the overall objective of actions and decision is the achievement of the maximum individual and / or societal satisfaction, utilitarianism is instead the doctrine of the *maximization of utility*. Transposing the two visions to the matter of preventing risk, a radical application of the first theory will lead to the question: *have risks to be accepted?*, whereas the second will lead to the question *have risk to be accepted in consideration of the associated collective utility*[231]?

The concept of collective utility is of rather complex operationalization and, when applied to the matter of preventing risks, has rather controversial consequences. As argued by Rawls in *A theory of Justice*[232], a strict application of the concept of "maximum collective utility" may lead, for example, to sacrificing the lives of some for the benefit of the whole[233]. On the basis of this consideration, he alleges that two principles of justice should be the pillars of "good" social contracts, namely the first principle and the second principle. The former advocates that each person should have the most extensive system of rights and freedoms which can be accorded equally to everyone (such as the right to life, speech, conscience, democratic rights and so on), whereas the second advocates that economic and social inequality are only justified if they benefit

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[228] For an account of the influence of Kant's deontological theories and their reflections on the moral debate gravitated around the universe of science in the second half of the past century, refer to C. Drucker (1998), Hannah Arendt on the need for a public debate on Science, Environmental Ethics, Vol. 20, No.3, 305-316.

[229] For a comprehensive history of utilitarianism I suggest the work of W. Shaw (1999), *Contemporary Ethics: taking account of utilitarianism*, Oxford, Blackwell Publisher.

[230] The example is discussed in C. Koorsgaard (1998), "Kant on dealing with Evil", in P. Sterba (eds), *Ethics: the big question*, Blackwell Publishing.

[231] In the first case the term "acceptable" is used in the connotation of "admissible". In the second case, "safety" replaces the concept of "utility".

[232] S. Freeman (2003), *The Cambridge Companion to Rawls*, Cambridge University Press. Reported by Ersdal and Aven (2008), *op. cit.* It is important to stress that the major contribution of Rawls theories funds their pillars on the concept of "social-contract" previously epitomized by I. Kant, together with T. Hobbes and J.J. Russeau. Rawls is in fact an exponent of the so-called "new contractualism", a current according to which the state can be thought as the result of an agreement or commitment (S. Moroni, 1997, *op. cit.*). With respect to the original formulation, the new-contractualism focuses on the concept of *justice* rather than the *legitimacy of power* and proposes forms of social contract which are not based on any form of social organization previously experienced in history. The social contract of Rawls has therefore the original character of an *hypothesis*, more specifically the hypothesis over the principles men free and rational will adopt under conditions of equality (*fairness*).

[233] This happened all over history, and keeps happening at our time; for example all the times the lives of soldiers are sacrificed.

all of society[234]. According to Rawls, the first principle is inviolable and universal and cannot be overruled in any case by the second[235]. In this respect, Rawls can be considered an exponent of the deontological current.

At this point I would like to apply Rawls's principles to Beck's theory over the "new inequalities" induced by the different exposure to contemporary risks, which in the German sociologist's vision is a primary characteristic of modern society together with the different distribution of wealth[236]. The application of Rawls principles to the matter of the social inequality characterizing the "risk society" leads to some truly interesting reflections.

Economical benefits associated to hazardous installations are of outstanding evidence and they are not questioned by Beck[237]. In his view, society is however called to "pay" such benefits in form of exposure to associated risks, which are systemic by nature and unequally distributed. If

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[234] Ersdal and Haven (2008), *op. cit*., at 199. The second principle of Rawls is known as the *principle of difference*. The application of this principle to model and organize society doesn't aim at leveling differences among individuals, such as differences due to nature (intelligence, ambitions etc) and fate (like the social status). It rather aims at organizing society in such a way that the general benefits produced by means of such diversities are accessible by all its members, under the condition that the same opportunities (of career, education, developments etc) are guaranteed up to the lowest social level which may wish to access them (refer to S. Moroni, 1997, *op. cit*., at 126).

[235] In this respect, Rawls can be considered an exponent of the deontological current who tried to overcome some of the fundamental controversies associated to the utilitarian current.

[236] Here I would like to argue over the "new uncertainties" induced by modernity in Beck's and Arendt's views and their different concepts of (environmental) *responsibility*. Both Authors argued over the consequences of modernization in terms of the forms of uncertainties created by human activities. The latter influence the course of nature. In Beck's view, such uncertainties consist of the new systemic forms of risk. In Arendt's view, such uncertainties consist of the unpredictability of natural developments together with social phenomena: "*man started to act into nature as he acts into history*". In the interesting contribution of Smith, the common denominator between the two visions stands in the fact that *politics will be, inherently and not accidentally, a politics of nature* (M. Smith 2006, *op. cit*., at 233). Yet whilst Beck stresses the responsibility of technological developments, their systemic and global nature and their increasing interdependency, the *organized forms of irresponsibility* are seen by Arendt as intimately connected to human actions and, in so doing, they still derive from the exert of individual freedom. For Beck, "*the individual in risk society is forced to take responsibility as a side effect of systemic failure*". Arendt instead alleges that an individual can always initiate political action (what she defines as the *initium* man) and can always decide to influence others by doing so: the organized irresponsibility doesn't constrain individual freedom, "*not even under a dictatorship*". It derives that whilst Arendt insists on the necessity of a politics addressed to (re)affirm the responsibility of individuals, Beck crystallizes a society in which nobody can be deemed responsible; in so being, Beck's society is dominated by a politics which can not escape from the same form of organized irresponsibility it created in technology. As I argued in my account of Beck's theory, and using again the metaphor of the phantom, in Beck the very phantom of *history* in his most "risky" development cannot be chained nor confined by neither individual nor collective rationality and actions. The interesting conclusions of Smith over the "unresolved issues" of the theories of Beck in comparison to the theories of Arendt are therefore rather close to those I derived in the previous Chapter. In his article, Smith alleges that "*Beck's account fails to take the nature of political action and environmental responsibility seriously…making both politics and nature subject to obscure systemic processes*" (M. Smith, 2006, *op. cit*., at 245). Furthermore, "*in the risk society, "side effects" can always serve to deflect our attention away from our individual responsibility*" (M. Smith, 2006, *op. cit*., at 245). Whereas the prevention of the consequences of major accidents risk falls under this responsibility, individual and collective, it is hence indubitable that the contribution of Beck fails in providing a sort of "way forward", denying to individuals the moral obligation and the very possibility of interfering with the course of events the societal economical pattern has somehow forced them to live in.

[237] U. Beck (1992), *op. cit*.

unequally distributed, we may conclude that only *part* of society is exposed to *certain* kinds of risk. Among them it is surely possible to account the site-specific risk posed by hazardous installations. Applying the second principle of Rawls for judging whether the collective benefits associated to such facilities justify the unequal exposure to risk of a group of individuals, we may conclude that the resulting inequality has to be justified. Applying the first principle of Rawls to the same situation, in consideration of its primary inviolability, we should instead conclude that the *prima facie* right to life of members of society is violated: the inequality is therefore *unjust*.

Yet hazardous facilities exist, and indeed part of society is more exposed to associated risks than others. A dilemma between the production of collective benefits and the defense of primary rights of members of society therefore arises. If the first principle of Rawls cannot be overruled by the second, and the exposure of part of society to risks violate their primary right to life, the only possible conclusion is that hazardous installations are *unethical* – and have to be banned.

How to resolve the dilemma?

As argued also by Ersdal and Aven (2008), Shader-Frechette (1991) and the scholars who contributed to the application of the risk-informed consent theory in the context of hazardous installations (Christou *et al* 2000, Kasperson 2005) the dilemma may be possibly overcome only by means of a *voluntary* acceptance of risks. The "intermediate choice" between banning risks from our society and creating new forms of social inequality can in fact be represented only by the voluntary acceptance of risks by the side of those members of society exposed to them, being such choice based on the exert of the primary right of *freedom*. If the part of society exposed to risks accepts them voluntarily, in fact the first principle of Rawls is fulfilled. On the other hand, such freedom can be exerted only in conditions of *awareness*: awareness can be achieved only by means of *information*. Here the risk-informed consent theory finds its theoretical justification.

However, a second problem remains unresolved. According to the second principle of Rawls, social inequality can be justified only when it benefits the whole society. Using Beck's words, we may rewrite that the *unequal risk distribution can be justified only when it benefits the entire risk society*. Nevertheless the voluntary acceptance of risks by the side of part of a community doesn't level inequality: it only resolves the associated ethical dilemma, without providing a solution to the matter of the benefits the whole society should have access to. At this point I argue that for "leveling" the risks associated to hazardous installations to the whole society and fulfilling both Rawls principles, the voluntary acceptance of risks by the side of part of it have to be compensated by means of *additional benefits*[238]. A risk-informed consent system including the compensation of risks (both monetary and / or non-monetary) is the only "good decision" which may resolve the ethical conflict arising from the described inequality while satisfying other fundamental obligations (Petterson and Hansson 2004), such as the obligation to information and compensation.

This remark over the "moral obligations" associated to the operation of hazardous installation leads to the work of Petterson and Hansson over the application of right-based moral theories to siting controversies[239]. Before developing the discussion in this direction I would strive for some conclusions over the risk-informed consent theory.

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[238] This conclusion is of fundamental importance. Here the dilemma arising from the application of the two Rawls principles to the matter of hazardous installation *and* the matter of the inequalities they create in the risk society of Beck are, though only theoretically, resolved. The compensation of communities or individuals living in the vicinity of hazardous installations is reflected in several European legislations, though with different degrees of definition and enforcement. However the matter of compensating the exposure to risk is out of the scope of the book, and it will be not discussed in detail.

[239] M. Petterson and S.O. Hansson (2004), *op. cit*.

As analyzed the risk-informed consent theory may resolve major ethical dilemmas associated to the installation of hazardous facilities and the deriving unequal exposure to risks. It is however necessary to argue over the *methods* enforcing its application. Ersdel and Haven individualize both *utility-based* and *right-based* methods. The cost-benefit analysis and the multi-attribute analysis belong to the first category. The zero-risk[240] and the risk-acceptance criteria belong to the second. As explained before, the impossibility of 0 risk associated to hazardous installation is acknowledged in literature as well as in European regulatory framework. I would therefore focus only on the risk-acceptance criteria belonging to the second category, which found applications in the majority of the European legislations addressing the matter of the prevention of risks.

The risk-acceptance criteria imply that a level of acceptable risk is previously defined and that risks are measured against them. In the case of hazardous installations, such criteria relate to the health of humans and the environment. In the majority of regulations addressing the prevention of major accidents risks, their acceptance is expressed in terms of probability of fatality, injuries or damages. Threshold values are often defined by law. For example, a generally accepted threshold under which risks are deemed acceptable is 10^{-6} / year probability of dying due to the exposure to a major accident[241]. In a risk-informed consent perspective, to the definition of risk-acceptance levels and the demonstration that such levels are met by means of appropriate safety measures, the acceptance by the side of the exposed individuals should follow.

A second criterion is the As Low as Reasonably Possible criterion which was introduced before. As already explained the rationale of ALARP is rather different in comparison to the risk-acceptance approach based on the definition of risk levels. The ALARP has in fact a focus on precaution: uncertainty shall be reduced by means of a constant increase of safety. The ALARP should be interpreted as a continuous implementation of safety measures aimed at reducing risks, regardless the eventual thresholds established by the Regulator. Though a limit of acceptability "under which" the ALARP principle becomes operational is necessary, its rationale is the "dynamic event" of safety achieved by means of a continuous decrease of risks (Weick 2001). On other hand, the operationalization of the ALARP principle in safety management implies the "reverse onus of the proof", which means that it has to be demonstrated that all identified risk reduction measures are implemented unless a gross disproportion between costs and benefits arise (Arcuri 2005, Ersdal and Aven 2008). In a risk-informed perspective, the application of the ALARP principle should therefore imply not only the definition and acceptance of a given level of acceptable risk, but also the demonstration that a continuous effort for reducing it is performed until the cost-benefits balance allows so.

Coming back to the ethical issue, and particularly to the distinction between deontological and consequentalist theories, I would conclude that the definition of risk-acceptance levels is a *deontological decision*, as it is based on the principle of preserving lives and what humans value regardless the comparison with other criteria, such as the economical one. This applies to both the methods described, as they equally involve a preliminary definition of what is "acceptable" or"unacceptable". On the other hand, the ALARP principle has also a consequentalist element, as the "reasonably possible" area is represented by the costs / benefits balance within which is indeed reasonable to continue reducing risks.

In conclusion, regardless the approach applied to define which level of risk is *acceptable* and which level *is not acceptable*, regulations addressing its prevention are based on a

[240] The "0 risk method" the two Authors refer to is the application of the "hard version" of the precautionary principle which will be discussed in the following.

[241] Refer to Chapter 3 and the description of the national legislations on the prevention of major accidents risk deriving from the implementation of the Seveso Directives.

deontological assumption, which is that *in front of risks, the primary right to life cannot be overruled by any other right.* On the other hand, as I will discuss in Chapter 4 when describing the different legislative orientations developed in European Countries, to this deontological assumption many social and economical considerations follow: a *consequentalist* element persists and it is represented by the very fact that hazards are permitted in our society on the basis of a cost-benefit reasoning.

This does not imply the conclusion that hazardous installations are necessarily *unethical*: the two principles of Rawls may be fully satisfied if the part of society exposed to associated risks accepts them voluntarily and once the deriving social inequality is leveled by means of further compensation. This voluntary acceptance can only be achieved by means of correct information, on the basis of which individuals may choose to accept risks *freely*.

This point is crucial: whereas the voluntary acceptance of risks passes through the provision of information over their likelihood and consequences. Establishing relevant obligations and regulating the duties of the involved actors becomes hence fundamental. In order to regulate the risk-informed consent approach, these obligations have to be explicitly formulated and enforced. This remark brings us back to the work of Petterson and Hansson over the ethical issues associated to siting controversy[242], which complete the overview of theories I referred to for deriving my final conclusions.

As previously for Ersdal and Aven, in the analysis of the two Authors the right of a company of siting and operating an establishment posing a risk to third-parties is implicitly in contrast with their right of breathing clean air or living in a risk-free environment. Also in their contribution the *prima facie* right of individuals is opposed to the social benefits associated to hazardous installations. However, rather than reflecting on the ethical principles which may justify the general problem of *existence* and *acceptance* of such installations, Petterson and Hansson focus on the resolution of the conflict arising among the parties involved in their siting[243].

Moving from the assumption that dangers *exist*, their analysis is addressed to elicit the moral principles grounding the *rights* of parties of posing or opposing against them. Such rights can be seen as *a clash of absolute principles* (Petterson and Hansson 2004): seemingly incompatible rights appear to coexist. How to resolve the deriving conflict?[244]

The two Authors propose an application of the concept of *residual obligation*. The original formulation of residual obligation dates back to the '30's of the past century and was further developed by Williams in his famous work of 1973 over the *remaining moral form of obligations*

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[242] M. Petterson and S.O. Hansson (2004), *op. cit*.

[243] The problem is similar to the ethical dilemma described before, with the difference that in the previous analysis I focused on the dilemma associated to the creation of social benefits and the inviolability of individual rights, while I now propose a reflection over the conflict between opposite parties, namely those *posing* and those *running* risk.

[244] This conflict may be also approached in economical terms. In this perspective risks can be seen as the negative externalities associated to hazardous activities (refer to the extensive contributions of Arcuri 2005 and Jongejan 2008, *op. cit*). Externalities are here *negative* as those that are not directly involved in the production of goods and do not benefit from their consumption are called to "pay" for the consequences of their production. Considering that such externalities are not expressed in market prices, a market inefficiency arises. Internalization of externalities' costs are therefore often proposed (Coase 1960, Eijgelshoven *et al*, 2000; A. C. Pigou 1920. Reported by Jongejan 2008, *op. cit*.). One example of internalization is the system of subsidies and taxations the State can impose to the Operators of hazardous activities. A second example of non-strict internalization is the implementation of policies aimed at reducing externalities at source. In the case of Seveso establishments, a third example of non-strict internalization is represented by the obligation of compensation to citizens and / or Authorities Operators may be subject to in all cases in which land uses have to be restricted.

that an individual has not to comply without the obligation loosing all of its force (B. Williams 1973, reported by Petterson and Hanssen 2004). In order to develop my reasoning towards a more concrete direction, I would then define the primary obligation associated to the installation of hazardous facilities citing the scope of the Seveso Directives which were analyzed before: *preventing the risk and minimizing the consequences of major accidents on humans and the environment*, obligation for which Operators and Authorities are hold liable. In theory the two actors may satisfy such obligations by means of a proper safety management, land use planning and emergency management systems, to mention the most important, without any need to satisfy residual obligations towards third parties. If the plant is operated in condition of safety, is sited correctly and the emergency response is effective, no further obligations may be in place.

On the other hand, the "humans" cited in the scope of the Directives are represented by the communities these actors are hold liable for. Are these communities object of residual obligations?

Petterson and Hansson individualize five main categories of residual obligations, namely

1. the obligation to compensate,
2. the obligation to communicate,
3. the obligation to improve,
4. the obligation to search for knowledge, and
5. the attitudinal obligations[245].

Considering the conclusions I derived from the previous analysis I will focus only on the first three residual obligations[246]. The obligation to *compensate* can result from the breach of the primary obligation stated in the scope of the Seveso Directive, which would be represented by the occurrence of an accident destroying, for example, houses in the surroundings. Nevertheless, it can also be interpreted as the obligation of compensating the exposure to risk of members of the community by means of additional benefits. In the first case, the liability principle may find application and Operators may be hold liable for the costs associated to the repair of damages; in the second case, Authorities may be hold liable, for example, for establishing a taxation system to be used for compensating the members of society exposed to risk[247].

The obligation to *communicate* applies when the omission of information may lead to the breach of the primary obligation: to give a meaningful example, in the community of Seveso was informed over the risks it was subject to, they could have decided not to live in the vicinity of the establishment or could have reacted to the emergency without suffering from the major damages it had to recover from.

The obligation to *improve* may derive from the breach of the primary obligation represented by a failure of the safety system by the side of the establishment, or by a lack of an efficient emergency response by the side of Authorities. It therefore implies the obligation to implement best-practice in the management of establishments and the surrounding context and searching for knowledge which may improve it. The obligation to improve may also be linked with the application of principle such the ALARP and BAT: the "as low as reasonable" risk and "best available" technology may be justified, in moral terms, as the obligation of improving the safety performance of establishments (hold by Operators), and the land use planning and response capacity of the surrounding areas (hold by Authorities).

In the analysis of Petterson and Hansson the residual obligations described so far may arise *per se* (i.e. they decay from the installation of the hazardous facilities) and as a result of the

[245] Petterson and Hansson (2004), *op. cit*., at 270-271.

[246] The fourth residual obligation of searching for knowledge is surely relevant to the analysis developed in this paragraph. Nevertheless, it can be considered as implicit to the obligation of improving and it is therefore not analyzed separately.

[247] The liability issue is discussed in the following section.

manifestation of risk into actual harm (i.e. they further decay from the occurrence of accidents). This distinction is very important, as it allows me to bridge the analysis of Ersdel and Aven on the "ethical justification" of the risk-informed consent theory with the concept of residual obligations, in so doing striving for some interesting conclusions over the ethical foundations the regulation of major accidents risk may refer to.

To do so, I will try to analyze the residual obligations deriving from the existence of hazardous facilities *per se* and by the manifestation of risk into actual harm. Furthermore I will define the actors subjects to these obligations, namely the risk *posers* (i.e. Operators) and what I would call the risk *managers* (i.e. Authorities). In a risk-informed system, the exposed communities are considered the actors object of obligations. Finally I will make some hypothesis over the practical translation of obligations into actions / activities, in so doing providing some enlightening example. The analysis is summarized in Table 6:

Table 6 – primary and residual obligations of Operators and Authorities associated to the prevention of major accidents

PRIMARY OBLIGATION	OPERATORS		AUTHORITIES	
Preventing the risk and minimizing the consequences of major accidents	Implementing appropriate safety measures on the basis of the provided criteria		Defining a risk-acceptability level and / or acceptance criteria (risk levels, ALARP, CBA, multi-attribute, land use planning requirements, etc), elaborating emergency-response instruments, monitoring hazardous installations, etc.	
RESIDUAL OBLIGATIONS	*Related to risk existence*	*Related to harm*	*Related to risk existence*	*Related to harm*
Obligation to compensate	Compensating communities exposed to risks	Compensating damages or losses attributable to the breach of the primary obligation	Compensating communities exposed to risks	Compensating damages or losses attributable to the breach of the primary obligation
Obligation to communicate	Delivering information about risks	Delivering information about accidents	Communicating information over risks	Communicating information over accidents
Obligation to improve	Implementing ALARP, BACT and related principles to safety management	Implementing *lessons learned* from accidents to improve the satisfaction of the primary obligation	Keeping decreasing risks associated to exposure (land use planning) and improving emergency response instruments	Implementing *lessons learned* from accidents to improve the satisfaction of the primary obligation

Table 6 represents an exemplification of the moral obligations which may be associated to the primary obligation derivable from the scope of the Seveso Directives. Coherently with the reasoning developed along the paragraph, such obligations are *moral* obligations and may represent the ethical basis on which regulation may be designed.

In conclusion, considering

- the deontological basis of the regulations addressing the matter of risk prevention,
- their intrinsic consequentalist element,
- the possibility of overcoming the ethical dilemmas associated to the siting and operation of hazardous facilities by means of the voluntary acceptance of risks by the side of exposed communities, and
- their compensation with additional benefits,

I would conclude that the analyzed residual obligations may integrate the set of ethical principles on which basis the presence of risks in our society may be justified and, above all, regulated. These principles may represent a sure guidance for the regulations aiming at preventing and minimizing the consequences of risks at a European framework level, being the ethical perspective underlying them a universal and cross-cultural perspective.

At this point I would like to address some remarks on the transposition of the ethical principles discussed so far into the specific case of territorial planning in the context of major accidents prevention. An opportunity to do so is provided by the interesting work of Moroni over the "ethic of territorial planning"[248]. In his book the Author argues over the main ethical theories applicable to the understanding of the territorial planning discipline at the scope of providing a theoretical framework on which basis a "ethical territorial planning" entering the new century may be funded.

Interestingly, the analytical route of Moroni reflects those followed by the Authors reported so far. The utilitarianism, the right-based theories and finally the neo-contractualism current are analyzed in depth together with their application to "territorial planning issues and policies". In his work, the theories of Rawls and the application of his two principles of justice for resolving "real cases of conflicts" find a privileged mention[249]. The principle of difference stated by Rawls should find application in all policies, regulations and ultimately decisions decaying from the basic "social contract" constituted by the state. When applied to territorial planning, the principle should support decisions opting for the alternative plan maximizing the allocation of those general goods which should be accessible by the whole society. This conclusion is based on the assumption that the practice of territorial planning is primarily concerned with the allocation of scarce resources (land, services, houses, etc), which should be hence allocated leveling the inequality of their distribution to the point of guarantying their access to the lowest social level[250].

The admirable effort of Moroni is defining which among these resources which are to be considered "general and primary" in a Rawlsian perspective. Which are the general and primary *spatial benefits* which have to be distributed equally in society in order to guarantee their access by the side of the less privileged parts of it? Interestingly, among them Moroni individualizes both material spatial benefits (housing, transports, green areas) and intangible spatial benefits such as *safety*[251]. At this point of his analysis he provides some criteria for individualizing the lowest social

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[248] S. Moroni (1997), *op. cit*.

[249] S. Moroni (1997), "Presupposti dell'approccio neocontrattualista di John Rawls: un punto di vista imparziale per affrontare situazioni reali di conflitto" (English: *Foundations of the neo-contractualism approach of John Rawls: an impartial point of view for facing real conflict situations*), *op. cit*., at 122.

[250] S. Moroni (1997), *op. cit*., at 128.

[251] More precisely, the Author alleges "[…] *the accessibility to various services and of meaningful spaces and the most general existence of a non-polluted and safe environment* […]" (S. Moroni, 1997, *op. cit*., at

level in a territorial perspective, which consist of the part of society having the most scarce access to both material and intangible spatial benefits and goods[252].

Without following the developments of his analysis further, I would like to concentrate on the interesting conceptualization of *safety* as a *spatial benefit*. In the context of territorial planning in the vicinity of hazardous installations, this concept is surely consistent: the hypothetical allocation of land uses to residential functions and, therefore, the presence of inhabitants in the immediate vicinity of potential accidents, corresponds to the creation of the "risk inequality" in society. According to the analysis of Moroni this *risk inequality* is therefore primarily a *spatial inequality*.

As argued before, such inequality is acceptable only when it benefit the whole society. According to the analysis of Moroni, it is therefore necessary to level the distributions of spatial goods in such a way that the general and primary among them are accessible up to the lowest level of society. Whereas safety belongs to them, it can be concluded that a *minimum level of safety has to be guaranteed to the whole society*. Considering safety as the non-violation of the primary right to life, the statement can also be reformulated as *the spatial inequality in society cannot overrule the access to the primary right of safety.*

Moroni doesn't address any specific reflection on the matter of site-specific risks. However, his conclusions over the horizon of an "ethical territorial planning" entering the new century are comparable to the conclusions I derived from the analysis of the Rawlsian principle applied to the theories of Beck and, more specifically, to the dilemmas associated with *primary rights* / *social inequalities* and *collective benefits* / *risk inequalities*. In his conclusions the Author argues over the necessity of re-affirming the validity of the neo-contractualism theories as general deontological principles of reference for all policies and choices aiming at leveling the inequalities in society by means of the allocation of primary (spatial) goods up to the more disadvantaged parts of it. This is what the Author defines as the aim of *fundamental planning decisions*[253].

It can be concluded that a "ethical territorial planning" in the context of major accidents risk has to focus on the allocation of the *spatial good of safety* in such a way that also the "spatially disadvantaged" parts of society can access a minimal level of it, which is the one that doesn't overrule the primary right to life of all individuals. As argued before, this is a deontological assumption and it is reflected in the primary obligation resulting from the scope of the Seveso Directives. According to the analysis of Moroni, this should consist of a *primary planning decision*. Nevertheless, a minimum level of safety (or of *acceptable risk*) has always to be object of definition, starting from the basic assumption that, as for other forms of technological risks, its level can never equal 0. As for the analysis developed before, to the deontological assumption that the spatial good of safety has to be equally accessible by all society, a series of "consequentalist" considerations follows. These consideration can be associated with the *secondary* or *incremental planning decisions* discussed by Moroni, according to whom only a dialogic relation among parties can guarantee the Rawlsian "fairness" of decisions.

It is possible to conclude that in the context of major accidents risk prevention and territorial planning the guiding ethical principles which may serve as a reference for formulating relevant policies are consistent. In both cases, to the deontological assumption that the primary

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130). I want to stress that the word used in the original text is *secure* in place of *safe*, being the English distinction between the terms "safety" and security" non translatable in the Italian language.

[252] The analysis of Moroni is rather complex and it is out of the scope of this book to provide its detailed account. In short, the conclusions of Moroni over the "ethic of territorial planning" are in favor of a neo-contractualism approach to planning, by means of which the "moral" planner tries to distribute spatial benefits focusing on the allocation of those minimally required by an equalitarian society.

[253] S. Moroni (1997), *op. cit*., at 193

right to life cannot be violated and that social inequalities should be leveled by means of the distribution of additional benefits, a series of consequentalist considerations follow. These are essentially represented by the matter of defining a level of *risk acceptability*, on the one side, and of *spatial safety*, on the other side. The obligation of information and involvement of the public is reflected, explicitly or implicitly, in both processes.

This ethical analysis served to provide an ethical key-of-reading of the Seveso Directives which were analyzed before and a possible cross-national framework suitable for improving their requirements. A complementary analysis stems from the following question: are the Seveso Directives a sufficient regulatory instrument to realize the objectives indicated by their scope? This is discussed in the following section.

3.4.1 From ethical to legal principles: is there a role for the precautionary principle in the context of the Seveso Directives?

After this brief journey in the universe of the ethical principles which may serve as a guidance for designing what Arcuri calls "sensitive risk policies"[254], I would like to focus on the legal principle which was briefly described in the Introduction, namely the precautionary principle. The understanding of the principle and its sometimes controversial interpretations is essential for a comprehensive discussion of the mandate of Directives such as the Seveso Directives and, in the context of this investigation, the relevant role of spatial planning.

As anticipated before, the PP has been variously formulated[255]. In order to provide an insight of the principle in terms of its role within the European regulatory framework I would refer to the version provided by the relevant European Communication[256], which most relevant parts read:

> *The precautionary principle should be considered within a structured approach to the analysis of risk which comprises three elements: risk assessment, risk management, risk communication. The precautionary principle is particularly relevant to the management of risk. The precautionary principle, which is essentially used by decision-makers in the management of risk, should not be confused with the element of caution that scientists apply in their assessment of scientific data.*
> *The implementation of an approach based on the precautionary principle should start with a scientific evaluation, as complete as possible, and where possible, identifying at each stage the degree of scientific uncertainty. (...) Decision-makers need to be aware of the degree of uncertainty attached to the results of the evaluation of the available scientific information. Judging what is an "acceptable" level of risk for society is an eminently political responsibility. Decision-makers faced with an unacceptable risk, scientific uncertainty and public concerns have a duty to find answers. Therefore, all these factors have to be taken into consideration. (...)*

According to the EU communication, measures based on the precautionary principle should be:

- proportional to the chosen level of protection,
- non-discriminatory in their application,

[254] A. Arcuri (2005), *op. cit*., at 30
[255] Refer to the inventory provided by O. Renn, 2005, *op. cit*.
[256] Communication from the Commission on the Precautionary Principle, COM (2000)1, 02.02.2000

- consistent with similar measures already taken,
- based on an examination of the potential benefits and costs of action or lack of action (including, where appropriate and feasible, an economic cost/benefit analysis),
- subject to review, in the light of new scientific data, and
- capable of assigning responsibility for producing the scientific evidence necessary for a more comprehensive risk assessment [257]

As deriving from the reported text the PP should find application in all cases in which there is not full scientific certainty (or a degree of scientific uncertainty) over the consequences of risk-bearing activities or products which may result in a threat for humans and the environment.

The fact that the principle applies in all cases in which there is a *degree of scientific uncertainty* over the *consequences of risks* represents the core of the heavy criticisms and debates the principle attracted since its first introduction into the Treaty on European Union in 1992[258]. As argued before, risk assessment is *per se* affected by a degree of scientific uncertainty, which derives from the *unpredictability* of the "how, when and where" risks will manifest themselves into harms.

In front of such uncertainty and in consideration of the level of harm accidents may provoke, a strict application of the PP would lead to ban dangerous installations from our society. The "hard interpretation" of the principle leads *de facto* to a risk-avoidance decision. The statement of Hanekamp crystallizes this position: "*the precautionary principle blocs innovation and thus hampers economic and social development*"[259]. On the other hand, the part of the Communication which reads

> "[…] *an assessment of the potential consequences of inaction and of the scientific evaluation should be considered by decision-makers when determining whether to trigger action based on the precautionary principle* […]"[260]

may reverse the interpretation of the principle: the object of evaluation are here the *consequences of inaction*, which shift the decision on whether taking or not taking action against *uncertainty* rather than the risk-bearing activities *tout court*. In this regard "[…] *the key elements of a precautionary approach are entirely consistent with sound scientific practice in responding to intractable problems such as "ignorance" and "incommensurability" (...) The acknowledgments of such difficulties under a precautionary approach may thus be seen as a more scientifically rigorous way of carrying forward the regulation of technological risk than would be their denial under a purely risk-based approach"*[261].

Having recalled these two diametrically opposed interpretations of the precautionary principle I will now reflect on its relevance to the case of major accidents risks. First of all, I would like to point out that the interaction with the cross-sector EWGLUP, active at European level for elaborating the Guidance for implementing Art 12, showed me that the different, sometimes opposed interpretations of the principle reflected the different and sometimes distant disciplinary backgrounds of its members. The interpretations of the PP as a "chain at the feet of technology" is more common among engineers and technicians than among social scientists and policy makers.

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[257] *Ibid*, at 4

[258] More precisely in Art. 174 (ex 130 R), reading "*Community policy on the environment…shall be based on the precautionary principle*".

[259] Hanekamp (2001), reported by R. Jongejan (2006), *op. cit*.

[260] Communication of the European Commission on the Precautionary Principle, at 17

[261] A. Stirling (1999), reported by A. Amendola (2001), *op. cit*.

Similarly, the consideration of the social factors influencing risk decision-making processes is more established among planners and regulators than risk analysts and experts. Why?

The scientific definition of uncertainty and the relevant interpretation deriving from the engineering-dominated optic may provide a reply to this question. As explained before, in the account of the different types of uncertainties in consequences modelling given by Christou, stochastic uncertainty and imperfect knowledge are defined. When it comes to the latter, Christou writes "[…] *our knowledge of the phenomena following an unexpected release is not perfect as it is usually based on empirical rules and observations from a limited number of accidents* […]"[262]. In principle, the limited number of accidents is what prevents the *ex-ante* analysis to become more accurate; but in order to validate the hypotheses done to perform it, analysts should assist to the occurrence of the relevant scenarios: which is exactly what the *ex-ante* analysis aims at avoiding. In my opinion, this "loop" is where the different interpretations of the precautionary principle origin. Whereas the uncertainty addressed by the principle is seen by many analysts as an insufficient criterion to justify precautionary decisions, being this uncertainty inherent to any analysis and limitedly validated by evidence, supporters of the principle see the indication of assessing the consequences of *inaction* given by the principle as the proper barrier for this evidence to manifest itself[263]. In simple words, if imperfect knowledge can be only perfected by means of unwanted accidents, adopting a precautionary approach doesn't mean being *un*-scientific; but rather accepting the inherent irreducibility of this imperfection and taking a perspective on decisions which is primarily ethical, and only complementarily scientific.

In this regard it is important to stress that legal principles are, indeed, primarily ethical principles. The precautionary principle in particular should be interpreted as guidance for legislations and not as a method or "rule" from which a univocal decision or consideration results. In this respect, the vagueness of the formulation of the principle within the various legislations referring to it is consistent with its "guiding" function[264]. The extremes represented by the "hard" interpretation of the principle and its hypothetical non application (what Arcuri calls *α-precaution*)[265] comprises a decisional space within which it would be difficult to defend the non-applicability of the described "soft version" of the principle. Decisions are always precedent to events; variables are always dynamic and historical and geographical conditions always specific. Whereas scientific analysis is not sufficient to provide satisfactory answers, implicitly decisions must be based on ethical considerations accounting scientific results and the uncertainty attached to them in the broader perspective of what *could* happen if *inaction* is taken.

The accident of Toulouse for example, which occurred in the immediate post 9/11 terrorist attack, occurred in a political climate during which the level of alarm for the protection of critical infrastructures was certainly higher in Western countries than ever in recent history. This "fact" can be considered one of the dimensions against which assessing the political and social consequences of the event; however they were surely unpredictable before 2001. In 2006, the Dutch government engaged in a lively debate concerning the availability on the Internet of risk-maps reporting the iso-risk contours of chemical installations together with the "mapping" of floods and other forms of

[262] M.D. Christou (1998), *op. cit.*, at 209

[263] This is obviously far from saying that analysts wish this evidence, namely accidents, to manifest itself; it only explains the possible different attitudes of analysts and non-experts towards the matter of uncertainty. This may be deriving, essentially, from different *forma mentis* and interpretations of the concept.

[264] A review of some of the European, OECD and UNCED communications and agreements in which there is a specific mention of the precautionary principle is provided by M. Adams (2002), The Precautionary Principle and the Rhetoric Behind, Journal of Risk Research, Vol. 5, No.4, 301-316.

[265] A. Arcuri (2005), *op. cit*., at 105

risk[266]. The core of the debate was whether the right-to-know of citizens should have been overruled by the implementation of the higher security standards required to cope with the current international terrorism threat. Even here, the decision of obscuring part of the freely available information had to be taken under conditions of uncertainty and ignorance: implicitly, it has been a *precautionary* decision.

In conclusion, similarly to other "terminology" or "conceptual" battlefields, striving for a univocal interpretation of the precautionary principle and taking a position in regard to its desirability and applicability is a false problem, which distracts the scientific community from the real one: are there cases in which a soft interpretation of the principle can provide valuable support to decision makers?

An illuminating contribution in regard is provided by the article of M. Adams over the "rhetoric behind" the precautionary principle. The Author argues how the tendency of striving for *omni-comprehensive* definitions of "precaution" is *per se* the loop the application of the principle wishes rather to resolve: "[…] *the concept creates a space in which protagonists encounter each other, and in which they sustain the sense of a common debate even when the interests at stake are fundamentally opposed* […]"[267]. In conclusion, the precautionary principle should be seen as the corollary of science-based decisions and should be rewarded as the approach "creating the space" within which actors discuss the way the available knowledge and information is differently interpreted and may be eventually used to reduce uncertainty. Two of the six cases of application of the principle individualized by the Author are indeed *where the scale of the threat is a factor* and *where there are a diversity of situations to be accounted for*, which can be re-written as *where the consequences of risks are serious and irreversible* and *where consequences are multidimensional*. In this regard, I would conclude that this "space of discussion" is consistent with the case of the major accidents which are expected to manifest themselves with a severe magnitude, for example because of the particular dangerousness of the substances involved or the proximity of sensitive, or historically and socially valuable targets.

Here, two elements of *precautionary* decisional processes have to be considered: the obligation to produce, delivering and sharing information among involved parties and the necessity of assessing the consequences of decisions in a multidimensional perspective. In a practical case, this would involve achieving a shared understanding of the uncertainty underlying the analytical process, accounting its different perceptions by the side of different parties, and considering the different perspectives on its relevance to final decisions. The *uncertainty* of risk analysts is not the "uncertainty" planners will think about when involved in the discussion; similarly, the *risk* analysts communicate about is not the same "risk" communities will perceive when involved in a debate. Achieving a common understanding of these concepts doesn't pass through the adoption of a common definition, but rather through the understanding of the others' perspectives and their repercussions in the different appraisal of risk. Starting from the assumption that a precautionary approach to risk decision-making would be suitable to create this space of interaction, it becomes rather difficult to defend its inapplicability.

To similar conclusions arrives the analysis of Keeney and von Winterfeldt over the appraisal of the precautionary principle in a decision-making perspective[268]. The Authors start with a series of assumptions, of which the first two (*uncertainties about risks can never be completely eliminated* and risk *decisions involve conflicting objectives and difficult trade-offs*) are surely

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[266] C. Basta *et al* (2006), Risk-Maps Informing Land Use Planning Processes, Journal of Hazardous Materials, Vol. 145, No.1-2, 241-249

[267] M. Adams (2002),*op. cit*., at 302.

[268] R. Keeney and D. von Winterfeldt (2001), Appraising the Precautionary Principle: a Decision Analysis Perspective, Journal of Risk Research, Vol.4, No.2, 191-202

consistent with the case of major accidents risk. Their common implication is that *decisions must be made with less than complete information*: even here, the stress on the primary role of information, their interpretations by the side of different actors and the triggering role of the principle for their production and further investigation is central to the conclusions of this contribution. The matter of "agreeing" or "not agreeing" with the application of the principle is therefore overcome by a simple consideration: "*one cannot reasonably evaluate the appropriateness of the principle as a policy without testing its consequences for the specific decisions it guides*"[269].

In conclusion, the application of the precautionary approach to the set of policies *and* decisions which have to be taken in the context of major accidents risk is consistent with their uncertain nature, the possible severe magnitude of their manifestation and the multidimensionality of their consequences. In this regard, applying the provided "soft interpretation" of the precautionary principle to the governance of major accidents risk appears reasonable. Furthermore, the role of a precautionary approach for "creating the space" within which sound information over the consequences of actions or inactions may be produced, delivered and shared is consistent with the ethical framework provided in the previous section, wherein the various moral obligations resulting from the primary scope of the Seveso Directives can be accomplished only by giving a primary role to information.

These conclusions are rather general and were derived looking only at the case of hazardous installations. Furthermore and more significantly, they were derived by referring only to one among the tens of definitions of the precautionary principle, adopted in a regulatory and not in a scientific context. In literature and in use among environmentalists, scientists, policy-makers and finally ordinary members of society there are different interpretations of the principle and the consequences of its application, which would affect the course of my reasoning significantly. However, understanding these perspectives and reflecting them in cross-disciplinary and participated discussions is what the application of the principle seems to aim at; in conclusion, taking a position *pro* or *against* the principle seems to be more damaging than possibly effective.

3.4.2 The liability matter

In the previous section, the ethical principles applicable to the governance of site-specific risks and suitable to overcome some of the main dilemmas associated to their siting was introduced. The analysis introduced the matter of defining the responsibilities of the actors involved in siting controversies and provided a simple classification of them in 3 categories: the risk *posers* (Operators), the risk *managers* (Authorities) and the risk *runners* (exposed individuals). At this point is worthy reflecting on the sufficiency of regulation such as the Seveso Directives for regulating their role and responsibilities into national legislations and for resolving the liability matter: who's holding the primary and residual obligations? Is a framework regulation a sufficient incentive for guarantying their compliance?

As explained before, in Europe hazardous installations are mostly governed by means of common-and-control regulations together with information regulation (Arcuri 2005)[270]. Next to this regulatory framework, liability rules are usually enforced by legislations.

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[269] R. Keeney and D. von Winterfeldt (2001), *op. cit*., at 200. This consideration characterizes the perspective of the Authors as a consequentalist approach to policy-making: the "goodness" or "badness" of the precautionary principle is assessed against the practical consequences of its application, and is not based on *a-priori* considerations.

[270] Regulation and liability are essentially complementary instruments for the governance of hazardous installations The first provides the set of requirements aimed at granting the permits to run and operate hazardous installations according to the risk prevention policy established by the Regulator. In this respect,

The matter of liability for hazardous installations is not addressed in any specific regulation at European level. Here, national legislations apply, such as Art. 6:175 of the Dutch Civil Code establishing a regime of strict liability for those who use or possess dangerous substances known to constitute a serious risk to persons and properties, and Art. 2050 of the Italian Civil Code establishing a special liability regime for dangerous activities. Nevertheless, a trend of promoting strict liability regimes in the case of environmental damages can be retraced in the developments of the European environmental law. The recently issued Directive 2004/35 introduces strict liability for environmental damages based on the "polluter-pays" principle[271]. Annex III of the Directives lists 18 Directives and one EC regulation whose common objects are the "dangerous activities" the Directive shall apply to. The Directive doesn't include damage to people and properties, which are those most commonly associated to major accidents. In this regard, two liability regimes co-exists: a strict liability regime for environmental damages and a liability regime based on tort law for damages to people and properties.

In the context of the Seveso Directives, it may be helpful to reflect on one question: would be a regime entirely based on regulation sufficient for preventing the consequences of major accidents? Are liability rules an additional incentive for Operators for investing in safety and, in so doing, improving the efficiency of the system?

Several scholars have argued on the desirability or regulation vs. liability rules, but only few studies had specifically focused on the matter of catastrophic risks. Among them, the contribution of Shavell proposes a classification of four cases to which regulation and liability should be applied differently[272], namely

1. Information differences between private parties and regulatory bodies,
2. Possibility of insolvency on the side of liable parties (also known as "judgment-proof problem"),
3. Lack of threat of a liability suit, and
4. Administrative costs.

According to the Author, the second and third case are better governed by means of regulation, whereas the first and the fourth tends to favor a regime based on liability rules. However, a combination of the two instruments should apply to the governance of hazardous installations due to the partial inefficiency of the two instruments when applied alone.

In order to reflect over the eventual consistency of the four cases (or "factors") with the case of Seveso installations it may be helpful focusing on them singularly. To do so I will recall the two actors individualized in the previous section, namely Authorities and Operators, assuming that the first are the *longa manu* of regulators for, in particular, the acquisition of information and the management of administrative costs.

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regulations may be defined *ex-ante* legal tools. Liability rules applies to the subject applying for running and operate such installations and defines the individual responsibilities and eventual penalties she may be called to face in case of non compliance with such regulations. This is why liability rules are often defined *ex-post* legal instruments.

[271] 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, OJ L 143/56.

[272] S. Shavell (1984), "Liability for Harm vs. Regulation of Safety", Journal of Legal Studies, No. 13, 357-374. Reported by A. Arcuri (2005), *op. cit.*, at 138. I want to stress that Arcuri doesn't bridge the analysis of Shavell to the specific case of Seveso installations. Her analysis embraces both nuclear and non-nuclear facilities, summarized under the common definition of "ultra-hazardous installations". As before mentioned, I do not support this generalization. The application of the analysis of Shavell to the case of Seveso installations is therefore fruit of my autonomous elaboration.

The obligation of information deriving from the Seveso Directive was discussed before. According to Shavell, liability rules should be preferred in all cases in which a difference or disproportion between the information possessed by Operators and Authorities exists. It is therefore necessary to reflect on the eventuality of *residual* information possessed by Operators after the compliance of such obligation and their relevance to the prevention of the consequences of associated risk.

According to the Seveso Directive, *all* information relevant to assess the risk associated to Seveso establishments *and* their compatibility with the surrounding environment shall be communicated to Authorities. In this regard it might be concluded that there is no residual information relevant to the prevention of risks which may justify the application of liability rules next to regulation[273].

The second factor (possibility of insolvency of the liable party) is more complex than the first and calls into play the matter of the assessment of the consequences of major accidents together with their development in the long term. An emblematic case in this regard is the disaster of Bhopal and the conclusion of the relevant legal controversy, after which the Union Carbide India Ltd mother company, the Union Carbide Corporation, was called to compensate the provoked damages for an amount of money rather ridiculous when compared to the long-term and still undergoing consequences of the catastrophe. Furthermore, after the acquisition of Union Carbide by the side of DOW Chemical in 2001, the actor "liable" for such consequences has no longer legal status. Furthermore, in consideration of the extent of the damages and their irreversibility, it is generally questionable whether a full compensability is possible in the case of accidents of such magnitude. With respect to the first remark, it may be concluded that liability rules may be "escapable"; with respect to the second, it may be concluded that liability rules are not a sufficient disincentive for the Operator, who could preventively assume that she will be not capable to afford the costs of damages. It should be therefore concluded that, in front of this factor, regulation should be complemented by liability.

The third case (lack of threat of liability suit) appears not consistent with the case of Seveso installations. In case of accidents harming or killing people penal law may apply and the "threat of liability" of Operators appears to be realistic enough to represent a sure incentive for preventing the occurrence of accidents and their consequences.

The fourth factor (administrative costs) is instead particularly consistent with the case of Seveso installations. As reported by Jones, in all European countries to the application for installing and running Seveso establishments more or less high administrative costs are associated[274]. Such costs can be seen as a compensation of the costs afforded by society to maintain a safety authority and are, in so being, an additional internalization of the costs of safety by the side of Operators. In this regard they appear to be consistent with the liability rule. Nevertheless, such

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[273] This conclusion is rather general and should not be interpreted *strictu sensu*. The limited disclosure of information by the side of the chemical industry about the dangerousness of certain substances is in fact a well know black page of the history of the sector. The most emblematic and well documented case is the one of VCM, or polyvinyl chloride, better know as plastic. Until 1974, the daily exposure of workers to VCM was of 500 parts per million (ppm). After the increasing evidence of its dangerousness, emerged from a number of liver cancers, carcinomas and brain cancers among the workers, several protected documents issued by chemical companies came to light during legal controversies. In one memo of DOW chemicals of 1959 the high dangerousness of exposure to 500 ppm of VCM was already mentioned. This information was kept confidential and not communicated to the regulator until the link between VCM and the mentioned effects were demonstrated by means of health investigations promoted in the early seventies by independent parties. See G. Bettin and M. Dianese (2002), *Petrolkiller*, Feltrinelli, Milano, at 90-91

[274] A. Jones (1997), *op. cit*

costs would be too high to justify their total internalization: such a regime would discourage the installations of hazardous facilities and will make society suffering from the lack of relevant benefits. Even here, a complementation between regulation and liability appears to be the proper instrument for regulating the installation and operation of Seveso establishments.

Having clarified the mutually complementary role of regulation and liability rules, it is useful to reflect on the reflections of such legal tools in Directives such as the Seveso Directives. First of all it is important t notice that regulations are characterized by *an intrinsic weakness*, deriving from two main aspects: their structural rigidity (regulations are less dynamic in changes than technology) and the lack of enforcement (from the emanation of European regulations to their enforcement there is a transitional period during which regulations are inefficient)[275]. The first factor is particularly evident in the case of the Seveso Directives: as demonstrated in the previous Chapter, the history of their emanation and the extension of their requirements developed as a periodic *lesson learned from accidents*. Some of them employed a considerable number of years before being translated into relevant requirements and even more to be transposed in national legislations.

The second issue can also be considered a factor of intrinsic weakness of regulation. As a matter of fact, European regulations are implemented into national legislations and further enforced within a period of four to five years from their emanation[276]. During this transitional period, liability rules may "bridge the gap" between a regime based on regulation and a status of facts in which such regulations are vacant.

A regime entirely based on regulation appears therefore rather inefficient and, in the European context, liability rules (i.e. tort law) complement regulation while acting as incentives for Operators for internalizing the costs of safety and preventing, in so doing, the occurrence and consequences of accidents. Nevertheless, to the establishment of regulation and the appointment of a competent authority acting as public "counter-part" of Operators, a second form of liability corresponds: the liability of Authorities towards the public. This point is particularly important and brings us back to the matter of the obligations of both actors deriving from Directives such as the Seveso Directive. Whereas Authorities are entitled to grant licences for installing Seveso activities and liable for establishing, among other measures, emergency planning and land use planning measures preventing the consequences of accidents, they implicitly become liable towards the public for the damages associated to the inefficiency of such measures. Therefore they should also be hold liable for compensating the public.

Looking back at the accident of Bhopal, some interesting reflections can be done. As reported before, the slums surrounding the Union Carbide establishment were, originally, abusive. Following a firm resistance of the inhabitants against the attempt to clear the area, the Government decided to grant ownership rights of the land where the slums were erected. This decision can be seen as a breach of the primary obligation of preventing the consequences of accidents by the side of Authorities, as *de facto* it represented the pre-condition of the tragedy. Theoretically, the

[275] In her analysis Arcuri individualizes also a third factor of weakness, which is the "lack of production or disclosure of information". In a system entirely based on regulation, she argues that Operators may have less incentives to continue producing or disclosing information due to the achieved accomplishment of *ex-ante* requirements (A. Arcuri, 2005, *op. cit*., at 148). Considering that next to command-and-control we find also information regulation, and that Directives such as the Seveso Directives have a primary focus on the production and communication of information by the side of Operators, I would question the appropriateness of this argument. I hence focus only on the two first two "factors of weaknesses" of regulation.

[276] The procedure available to the Commission to oblige Member States to comply with EU legislation is laid out in Art. 226 (ex-169) of the EC treaty. A contribution addressing the problem of its implementation and enforcement into national legislations is provided by H. Somsen (1996), *Protecting the European environment: enforcing environmental law*, London, Blackston Press.

Operator of the establishment could have appealed to this decision to discharge her responsibility with regard to the consequences of the accident. Here, a two-fold liability regime should therefore apply in order to establish "who compensate what".

This matter is particularly consistent with the case of "Seveso situations" and is differently addressed in European legislations, notwithstanding the general lack of specific legislations addressing the matter of liability and compensation of damages related to dangerous activities. Having clarified that a liability regime exists in European and generally Western legislations, it is necessary to stress that its "weight" is different also depending on the legislative backgrounds of different countries.

In the United Kingdom, the appointment of the Hazardous Substances Committee and the establishment of a national Safety Authority entitled to grant licences to and monitoring the activities of hazardous installations followed a problematic debate over the coherency of such system with the common law system. In common law, *ex-ante* regulation and legally binding provisions are represented by a dynamic corpus of sentences rather than by laws. Traditionally, the liability of subjects is a primary legal principle: the establishment of a safety regulatory framework and a relevant safety authority has inevitably involved the liability of the newly established authorities in the case of damages. In France, one fundamental element of the new legislation on risk prevention addresses exactly this problematic aspect. The assignment to Prefects of the right of expropriation of private properties (followed by compensation in all cases in which existing "Seveso situations" are not resolvable by means of a decrease of the risk at source) is a clear example of the introduction of a strengthened liability both for Operators and Authorities.

This aspect of the national implementations of Directive Seveso II will be extensively discussed in Chapters 3 and 4. In the following, a discussion of the legal principle which cannot be excluded by any investigation on risk is discussed: the precautionary principle.

3.5 Concluding remarks

This Chapter collects a number of reflections on the history, mandate and interpretation of the Seveso II Directive in general and Art 12 in particular. Different perspective were used for analyzing the scope of Art 12 and its regulatory developments up to the recent Guidance issued by the European Commission.

The ethical perspective found a privileged role in this analysis. This results from the conclusions of the previous Chapter and from the intention of providing a perspective on the Seveso Directives focusing on the cross-cultural and cross-disciplinary moral obligations resulting from their scope and requirements.

However, there are also methodological and political issues associated with the introduction of Art 12 in 1996. The late emanation of the Article in comparison to other fundamental requirements of the Seveso II mirrors the difficulty of this policy-formulation process. Coherently with this difficulty, the Chapter described the challenges associated with the implementation of Art 12 and analyzed the principles provided by the recent Guidance issued by the European Commission adopted in 2006. The Guidance mirrors the heterogeneity of the several European approaches to the matter of major accidents risk in land use planning while echoing the lack of an equally applicable method for bridging the two banks of risk analysis and land use planning. The Guidance does hence not fill the "methodological gap" between the two disciplines and professional practices in a way suitable to be applicable across Member States; rather, it offers a set of options for their integration derived from the most established national practices.

This aspect of the Guidance confirms the existence of an inherently national character in the different routes "from risk to trust" (De Marchi 2000) which have been traced in European

countries according to their historical, legislative and territorial backgrounds. This will be further discussed in the following Chapter, wherein the five selected national implementations of Art 12 and their methodological and procedural orientations are described.

CHAPTER 4

Risk, territory and society in selected European practices: a survey

Diversity (in politics): the political and social policy of encouraging tolerance for people of different backgrounds

http://en.wikipedia.org/wiki/Diversity

In this Chapter the results of the investigation of the "state of art" of land use planning in the context of MA risk performed between the end of 2004 and the summer of 2007 by the Major Accident Hazard Bureau of the European Commission are reported[277]. The investigation was performed as part of the activities of the European Working Group on Land Use Planning, appointed in early 2004 following the emanation of the first amendment to Directive Seveso II. Results were used as reference for the elaboration of the Guidance for the implementation of Art 12 of Directive Seveso II adopted by the Commission in November 2006, and were further elaborated and collected within the supporting document *Roadmaps.*

In this Chapter the five country-profiles of the United Kingdom, France, The Netherlands, Germany and Italy are further enriched with a number of references and documentations which were not considered for elaborating the *Roadmaps* document. In the following section, some words of caution concerning the research method which was adopted to conduct the investigation are given. Finally, before the five country-profiles a general overview of the matter of risk of major accidents in Europe derived from the investigation conducted in the context of the ESPON Hazard Project[278] and further elaborated by Shmidt- and Kallio in 2006[279] is given.

4.1 Research method: some words of caution

The *Roadmaps* document developed as a sort of "live" document in the context of the EWGLUP activities. The editorial group formed to achieve the results of the investigation

[277] It's worth repeating that the results of the MAHB survey collected in this Chapter were collected as part of my Traineeship in the Institute. The investigation started in the fall of 2004 and was periodically updated until the summer of 2007 through the consultation of the members of the EWGLUP. Prior to the publication of the JRC Technical Report *Roadmaps* at the end of 2008, wherein the 5 country profiles resulting from the investigation are reported, results were validated through further primary (scientific) and secondary (institutional and governmental) literature review. Minor changes to legislations could have occurred in the last months of 2008 and the course of 2009 which are not mirrored in the Chapter. However, the country-profiles are a reliable portrait of the selected national legislative systems and practices relevant to Art 12.

[278] European Spatial Planning Observation Network (ESPON), Project 1.3.1, *op. cit.*

[279] P. Schmidt-Thomé and H. Kallio (2006), Natural and Technological Hazard Maps of Europe, in P. Schmidt-Thomé (eds), *Geological Survey of Finland*, Special Paper n. 42

comprised the five national delegations of the respective countries. Within these delegations, industry representatives as well as national authorities were represented.

The document developed as a sort of "live report" thanks to the cooperation among the coordinators of MAHB, the PhD project and the members of the editorial group. Some words of cautions concerning the research method and results are therefore necessary. How to validate the results of a sort of back-and-forth consultation, involving in time different experts and representatives of different authorities?

First of all, it's worthy to underline that this sort of interactive investigations and the method of questionnaire-surveys are common in the context of European research. The scarce yet valuable literature on selected national land use planning practices in the context of the Seveso II Directive precedent to and referenced by the *Roadmaps* was elaborated adopting a comparable method[280]. Considering the context of the survey and the purpose of the questionnaire the latter has to be regarded as a "torch" used to shed light on the general aspects of the implementation of Art 12 in the selected countries; not as the only source of information used to elaborate the country-profiles. Divided in three parts, the questionnaire comprised both a number of queries over the methodological aspects of the implementation of Art 12 and a number of queries over the procedural aspects of LUP practice. A third part gave room to the EWGLUP members to give a first feedback about the meaning and prioritization of the key-concepts which should have informed the principles provided in the Guidance the implementation of Art 12.

The validation and verification of the provided information was performed by means of the available primary and secondary literature, namely scientific literature, governmental publications and national legislations respectively. Results of other European surveys over the state of implementation of Art 12 were also used as reference for a validation of the results of the investigation[281]. Consequently, the elaboration of the final five country-profiles employed a long period of time: the final consultation of the EWGLUP delegates occurred in the summer of 2007[282], whereas the final editing of the *Roadmaps* document took place in the first half of 2008.

In this Chapter, the information collected in the *Roadmaps* is enriched by further literature review. One of the additional efforts has been providing a more detailed overview of the territorial distribution of the risk of major accidents in Europe by exploring different institutional source of information (such as web-portals of Ministries and safety agencies) and recent literature. A general overview of the risk of major accidents in Europe, which was not provided in the *Roadmaps*, is therefore reported in Fig 11. The map is a synthetic illustration of the density of chemical production establishments per km^2 in European regions, classified regardless the amount and type of substances. Information were derived from a number of European d-bases such as EPER and

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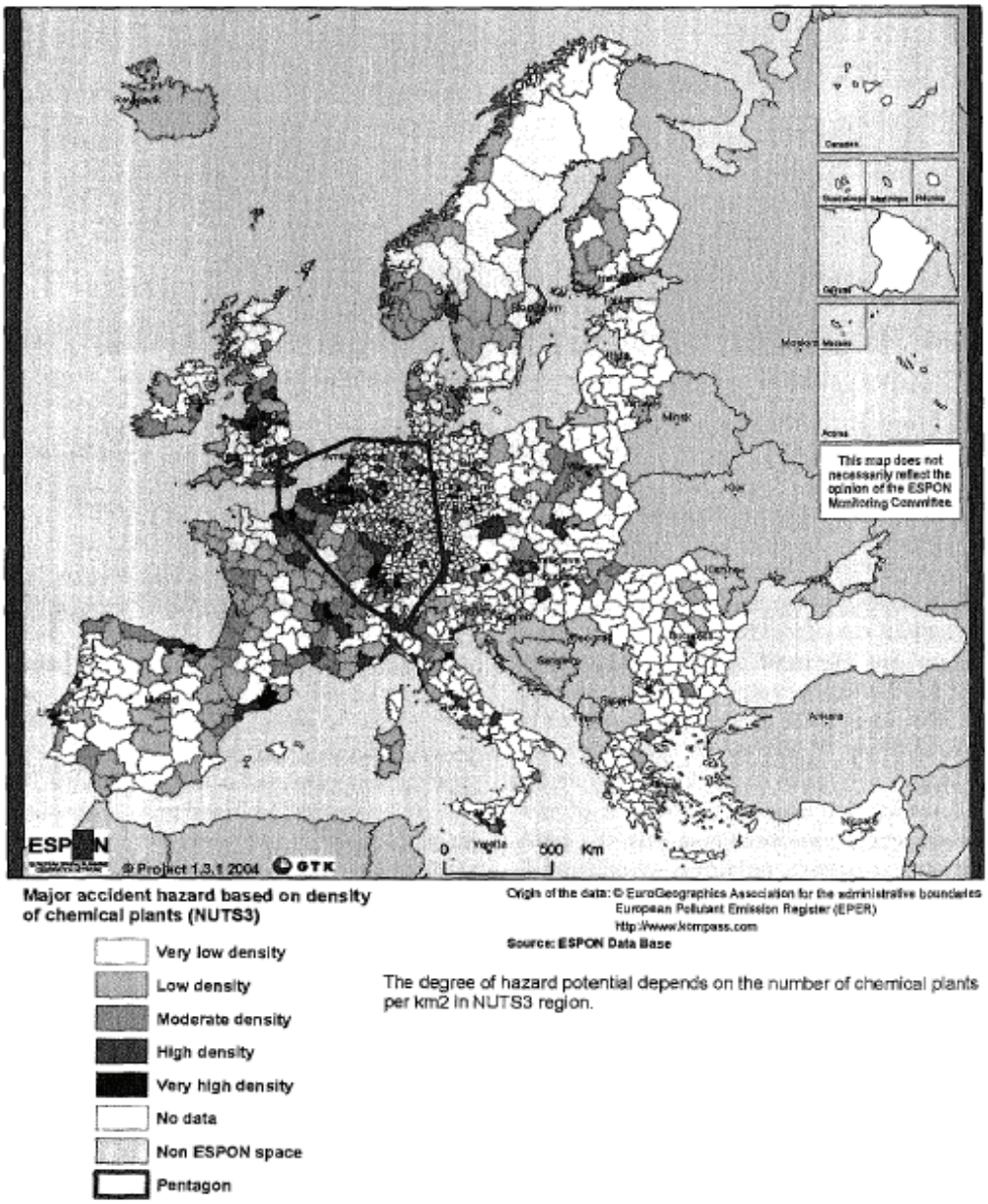
[280] Beside some comparative studies already mentioned in the course of the book, I refer among others to M. D. Christou and S. Porter (1990), *Guidance on land-use planning use required by Council Directive 96/82/EC*, Institute for System Informatics and Safety, Joint Research Centre, EUR 18695 EN; M. D. Christou, A. Amendola and M. Smeder (2000), The Control of Major Accidents Hazards: the Land-Use Planning Issue, Journal of Hazardous Materials Vol. 78, Elsevier; A. Jones (1998), *The Regulation of Major Hazards in France, Germany, Finland and The Netherlands*, HSE (eds.), Crown Edition, London.

[281] Refer to the report *Questionnaire on progress made with the implementation of the Directive 96/82/EC on the control of major-accident hazards involving dangerous substances (SEVESO II),* EU Commission, 2004; see also the related *Synthesis of the replies to the questionnaire on progress made with the implementation of the Directive 96/82/EC (Seveso II Directive)*, EU Commission, 2004. Both documents are available at: http://www.europa.eu.int/comm/environment/seveso/index.htm . Last visited: November 2006.

[282] The final consultation took place at the last plenary meeting of the EWGLUP in Leuven (BL) on the 6th of June of 2007. Notes on the outcomes of the meeting are downloadable at the website of JRC http:///landuseplanning.jrc.it , last visited: April 2008..

KOMPASS[283]. Coherently with the distinction between nuclear and non-nuclear risks, the map doesn't report nuclear facilities but only chemical facilities. The map aims at providing a general overview of the distribution of chemical plants in Europe, highlighting in so doing the concentration of establishments more likely to pose a risk on a local and regional scale. As shown in the map, the highest density of establishments regards the macro-region comprised between the north of Italy, west Germany, east France and the Netherlands (the so-called "pentagon region")[284]. Other regions such as the southern and northern regions of Europe reports from a very low to a low density of plants. The map is shown in Fig 11:



[283] P. Schmidt-Thomé (2006), *op. cit.*, at 35
[284] *Ibid*, at 36

Share of chemical plants/km²/NUTS 3 level	Density (hazard) class
[Share]=0	1=Very low
[Share]=0,000001-0,000318	2=Low
[Share]=0,000318-0,000830	3=Moderate
[Share]=0,000831-0,002535	4=High
[Share]=0,002526-0,066781	5=Very high

Fig 11 – the concentration of establishments in Europe / km^2 (from Schmidt-Thomé and Kallio 2006)

"High density" and "very high" density areas are visible in all the 5 countries selected for the analysis of their land use planning practices in the context of the Seveso II Directive. Notably, Germany, France, the Netherlands and the United Kingdom show the highest concentration of establishments in Europe. Some of the "very high" density areas visibly correspond to petrol-chemical harbors such as Rotterdam in The Netherlands and Venice in Italy. Here a high concentration of petroleum-liquefied gas storages (LPG) and chemical plants is present.

Keeping this map as general reference of the distribution of chemical plants in Europe, I will now provide an overview of the selected country-profiles, enriched with a number of references which were excluded or not available at the time of the elaboration of the MAHB investigation. For some of them, depending on the available information, more detailed maps are provided. However, also in consideration of the inhomogeneous availability of territorial information and particularly of risk-maps, the focus of the profiles is on the legislation and procedures in place for the regulation of major accidents risk with particular regard of the "rationale" of land use planning evaluations. Their comparison will be further discussed in the following Chapter.

4.2 France: lessons learned from Toulouse

In France, 608 Top- tier establishments and 495 lower-tier establishments were operative at the time of the investigation[285]. The Country consists of 96 departments grouped within 22 larger administrative provinces. The definition of land use planning policies with regard to major accidents risk is due to the Ministère de l'Ecologie, du Développement et de l'Aménagement Durables (MEDAD). Other three Ministries (the Ministry for Industry, the Ministry for the Interior and the Ministry of Labour) share the responsibility for major hazards prevention and control[286].

The regulatory developments of the Country in the field of major accidents risk prevention were indelibly marked by the accident of Toulouse in 2001 (Cahen 2006, Dechy *et al* 2002, Salvi *et al* 2005). After the political earthquake provoked by the accident, the French government promoted a sound revision of the entire corpus of policies and regulations addressing the matter of risk prevention, with regard of both technological and natural risks. In the Communication of the Ministry of Environment and Sustainable Development of the September of 2003[287] the influence of the accident for the developments of the new regulation emanated in 2003 is explicitly acknowledged: "*Six years after the publication of the* [Seveso] *Directive, the law dated 30 July 2003 concerning the prevention of technological and natural risks and the repair of damage was*

[285] C. Basta *et al* (2008), *op. cit*.
[286] A. Jones (1997). *op. cit*., at 68
[287] Communication of the Ministere de L'Ecologie et du Devloppement Durable (2003), *A new law on risk prevention***,** Paris, 01.09.2003. Retrieved from http://landuseplanning.jrc.it . Las visited: April 2008

published on 31 July 2003; it aims to supplement the existing legislative provisions. This law is directly inspired by the "feedback reports" that followed recent technological and natural catastrophes, the explosion at the Grande Paroisse factory (AZF) in Toulouse, the failure of Metaleurop Nord at Noyelles Godault, the floods of the Somme, the Gard and the Hérault rivers. The parliamentary working groups, the corresponding reports by the general inspectorate[5] and the results of the national coordination carried out at the end of 2001 following the Toulouse catastrophe inspired the articles that were put to Parliament. The law has three chapters, or "titles". In addition to the first one devoted to technological risks, the second is devoted to natural risks, and the third to common provisions. These successive laws have reiterated and reinforced the principles of operator liability and the primacy of prevention […]"[288].

The first principle is particularly strengthened by the new French legislation, to the point that was object of a specific mention when the new law was presented to the public[289]. The part of the new law dedicated to technological risk has the primary scope of strengthening the regulation of the siting and urbanization control around establishments and the flows of information between Operators, Authorities and the public over the risk of the major accidents.

Before the law of July 2003 came into force the methodological orientation of the country with regard to the siting of Seveso establishments was strongly deterministic (Cahen 2006, Christou and Porter 1999, Jones 1997, Salvi and Gaston 2004). This orientation is still reflected among the provisions of the primary legislative reference addressing the protection of humans and the environment, the Code of Environment (Fr. *Code de l'Environnement*)[290], wherein the license to operate hazardous installations is subordinated to a sufficient distance between the establishments and people located in the vicinity (Salvi and Gaston 2004). Theoretically, installations posing a risk to people living in the vicinity could not be licensed in the French territory. The principle appeared for the first time in the French legislation in 1810, when it was object of a Napoleonic decree[291], reinforced in the law of 1917 on hazardous plants and further reinforced in the law of 1976 which was revised and replaced by the current Code of Environment in 2000 (Salvi and Gaston 2004).

According to the principle, the deterministic approach to land use planning regulated in France in 1989 was based on the definition of pre-selected scenarios, which probabilities were not object of estimation (Cahen 2006, Salvi and Gaston 2004). Such scenarios represented the worst-scenario for each type of event according to the maximum quantity of dangerous substance treated or stored within the largest pipeline, tank or unit of the plant. According to these pre-selected scenarios, two zones (Z1 and Z2) or lethal and irreversible effects were individualized. The first zone could not be used for new constructions, installations of further new residential permits or roads rather than those necessary for operating the establishment; furthermore, the number of persons present could not increase apart from the activity for which the establishment was licensed. The second zone could not be used for constructions or installation of new establishments receiving the public, high rise buildings, sport areas and in general areas of public use; increase of people

[288] *Ibid*, at 1
[289] *Ibid*, at 2
[290] Code de l'Environnement , Version consolidée au 4 avril 2008, online. Available at www.legifrance.org/ . Last visited: April 2008.
[291] *Rapport du 9 Octobre 1810 de l'Institut `a l'empereur Napoleon, 1810*. Reported by B. Cahen (2006), Implementation of New Legislative Measures on Industrial Risks Prevention and Control in Urban Areas, Journal of Hazardous Materials, No. 130, pp.293-299

present due to the activity had to be limited (Jones 1997)[292]. A guidance published in 1990 defined the criteria for defining the Z1 and Z2 areas[293]. A three-step procedure was used:

1. The national competent authorities notified the distances resulting from the Safety Report to the local community, responsible for land-use planning;
2. The local community and the state negotiated the "appropriate distances" accounting both the local plan necessities and the consequence-based distances determined by the state;
3. The local community regulated the local land-use plan and restricted the construction rights in the individualized zones.

In case of disagreement, the state had the right to impose to local communities restrictions on land-use planning. For new sites, built after 1989, such restrictions were compensated by the Operator of the establishments generating risk. For pre-existing sites, the restrictions imposed on land use in large zones (up to 1 km from the source) were not compensated.

The underlying philosophy of the French deterministic approach was that once sufficient measures were in place to prevent the worst scenarios, sufficient measures were implicitly in place for any less serious incident. The limits of the approach which were made evident by the accident of Toulouse are various. The most evident among them was that the regulation, based on pre-selected reference scenarios, had led Operators to not perform a detailed QRA and to not investigate the actual risk posed by establishments, limiting the insight of the specific events which could occur due to the design and disposition of the various units within the plant (Salvi and Gaston 2004). A second important limitation was instead due to the non-retroactivity of the legislation adopted starting from 1989: as observed by Cahen, the legislation was effective for limiting the creation of new risks due to new installations or developments, but had practically no effect to the decrease of vulnerability of the existing situation crated prior to 1989. This point was particularly considered during the revision which would have led to the emanation of the new legislation in 2003 and relevant provisions represent its main innovative elements.

4.2.1 Operating permit procedure

The licensing procedure in France is regulated by the law No. 76-663 of July 19, 1976 on classified installations for environmental protection and its related decree No. 77-1133 of September 21, 1977. Article 3 of the 1976 law concerns specific classified installations with a major accident potential. These classified installations are known as AS (French *Autorisation avec Servitudes*) or top-tier SEVESO establishments. Operators must hold the permit or Prefect Authorization for siting and running establishments[294]. The Prefect releases licenses on the basis of the advice of DRIRE, the institutional body responsible both for the assessment of Safety Reports, the consultation of local authorities and other involved parties. The Prefect is thereafter responsible for submitting and exchanging relevant information with the Mayor, responsible for considering them when performing land use planning instruments.

Industrial activities are classified according to their potential dangerousness and eventually to their potential impacts on the environment. The classification is listed in the following:

- Low dangerousness: declaration scheme "D". A simplified declaration is required at the *Prefecture*;

[292] A. Jones (1998), *op. cit*., at 93

[293] According to Cahen, this guidance was suppressed by the Ministerial Communication Circulaire du 30 Septembre 2003 relative au rapport de l'inspection des installations class´ees concernant les risques industriels r´ealis´e dans le cadre de l´´elaboration des porters `a connaissance ou des plans d'urgence externes (BOMEDD no. 03/22).B. Cahen (2006), *op. cit*., at 294

[294] In the French system, the Prefect is national representative at local level.

- Medium dangerousness: authorization scheme "A" [295] . A Safety Report and an environmental impact assessment (EIA) procedure are compulsory;
- High dangerousness: authorization scheme with land-use restrictions "AS"[296]. Land use restrictions are possible in addition to A establishment requirements.

For A and AS establishments, the Safety Report provides relevant information to competent authorities for the authorization, rejection or authorization of operation subject to conditions. Hereby the Prefect is enabled to evaluate the compatibility of the establishment within its territorial context using a national acceptability matrix known as the "MMR matrix" (French *Mesure de Maîtrise des Risques*). Relevant information have to be communicated to the Mayor.

4.2.2 Territorial governance and French land use planning instruments

Land use planning in France is based on the *Code de l'Urbanisme*[297], which Article 110 prescribes that the destinations of land uses must ensure public health and safety and, specifically, that the prevention of technological risks are taken into account within the urban planning instruments (Art. 121-1). Urban planning is performed at two levels: the first is the *Schema De Coherence Territorial* (French acronym *SCOT*), defining a general city-regional level project. The time horizon of this plan is of 30 years and in this respect it can be considered as the strategic planning instrument. The second level is the *Plan Local d'Urbanisme* (French acronym *PLU*), defining the general regulation for land uses within municipalities. The *PLU* contains, for instance, the different land use destinations and the rules applicable to the territory falling under the municipal administration.

Land use planning policies deriving from the implementation of the Seveso II Directive were included in the framework of the law of December 13, 2000 on urban renewal[298]. The law was the first requiring to local authorities to account the industrial risk in their LUP documents. The most relevant policy developments following the emanation of the Seveso II Directive are the law no. 2003-699 of July 30, 2003 on the prevention of technological and natural risks and the repair of damage[299], where new measures and tools were prescribed. As before mentioned this law is derived from the lessons learned from the AZF accident in Toulouse of 2001 and from the major floods in the southern part of France in 2002. The new law prescribes two new instruments for dealing with top-tier Seveso establishments. Their main objective is improving the efficiency of limitation of future constructions while dealing with existing situations and can be summarized as in the following:

- plans for technological risk prevention mitigating the residual risk for existing situations (Fr. acronym *PPRT*) have to be defined and implemented in the areas affected by industrial risk created by top-tier Seveso establishments;
- for new developments in existing sites, or modification of existing installations that creates additional risk, the constraint imposed on land use (French *servitudes*) because of the additional risk has to be financially compensated by the Operator of the installation posing the risk.

4.2.3 Systematic method for land use planning in risky areas

In the Safety Report, major accidents are described according to three parameters:

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[295] The authorization scheme A regarded 61.000 establishments circa at the time of the investigation.
[296] The authorization scheme AS regarded 600 establishments circa at the time of the investigation.
[297] C. Basta *et al* (2008), *op .cit.*
[298] *Ibid*
[299] *Ibid*

- probability: it is assessed against classes of probability according to a national scale of five categories from A (> 10^{-2}/year) to E (<10^{-5}/year). The probabilities of top-events are calculated taking into account the information provided by the Operator or the relevant industrial sector. The Operator shall provide information over the implemented risk control measures;
- intensity (or magnitude): this is determined by calculation of the effect distances, which are assessed against national effects thresholds. Four types of effect are defined: significant lethal effects, first lethal effects, irreversible injury, reversible injury or broken glass. Distances are calculated for each hazardous phenomenon taking into account barrier performances (response times, effectiveness) and site conditions (weather conditions, etc.);
- severity of effects: this is established assessing the number of potential victims within the mentioned effects distances. The impact is hence classified depending on the number of victims for each type of effect. National regulation provides five categories of effects, reported in Table 7:

Table 7 - Severity scale depending on the intensity (effect threshold) and on the number of exposed people)

	Significant lethal effect threshold	Lethal effect Threshold	Irreversible effect threshold
Disastrous	>10	>100	>1000
Catastrophic	1 to 10	10 to 100	100 to 1000
Major	1	1 to 10	10 to 100
Serious	0	1	1 to 10
Moderate	0	0	<1

Once the hazardous phenomena and major accidents have been characterized according to probability and effect classes, relevant planning decisions are taken according to a national acceptability matrix. Three areas are defined:

- An unacceptable area ("NON" areas) for which the risk is deemed too high: the installation cannot be authorized in its current state;
- An acceptable area for which authorization can be given;
- An intermediate area ("MMR" areas) in which authorization is given after verification that cost-acceptable risk control measures have been put in place.

Tab 8 reports the national matrix:

Table 8 – the matrix combining probabilities of classes and effects area used for land use planning evaluation according to the new French legislation

Probability / Gravity	E	D	C	B	A
DISASTROUS	Non	Non	Non	Non	Non
CATASTROPHIC	MMR	MMR	Non	Non	Non
SIGNIFICANT	MMR	MMR	MMR	Non	Non
SERIOUS				MMR	Non
MODERATE					MMR

A set of zoning principles are also set out in the national *PPRT* guide. Such principles are reported in Table 9.

Table 9 – the PPRT zoning principles

Regulated zones	Future land-use planning and construction measures	Possible real-estate measures
Dark red	Ban on new construction	Expropriation Relinquishment
Light red	Ban on new construction but possibility to extend existing industrial buildings if they are protected	Relinquishment
Dark blue	New construction possible depending on limitations on use or protection measures	
Light blue	New construction possible depending on minor limitations	

General zoning principles are related to alert levels (French *aléas*), which are the combination of intensity and cumulative probability. A final table combining alert levels, zoning principles and allowed measures is reported in Table10.

Table 10– General zoning principles combined with the different "alert levels"

Maximum intensity of the toxic, thermal or overpressure effects on humans at a given point	**VERY SERIOUS**			**SERIOUS (LETHAL)**			**SIGNIFICANT (IRREVERSIBLE)**			**INDIRECT**
Cumulative probability, distribution of dangerous phenomena at a given point	**>D**	**5E TO D**	**<5E**	**>D**	**5E TO D**	**<5E**	**>D**	**5E TO D**	**<5E**	**ALL**
"Alea'" level	**VH+**	**VH**	**H+**		**H**	**M+**		**M**	**LOW**	
ZONING	**DARK RED**		**LIGHT RED**			**DARK BLUE**			**LIGHT BLUE**	

As mentioned above, the new French law requires to local authorities to elaborate the technological risk prevention plans *PPRT*, which objective is to resolve difficult land use planning situations inherited from the past and to set the framework for future land use planning. These plans aim at mitigating the residual risk, after risk prevention measures at source have been taken.

Basically they limit an area within which requirements can be imposed on existing and future buildings, namely:

- Restrictions of future construction and land use;
- Consolidation of existing constructions (for example, blast-proof windows);
- Expropriation of existing buildings and constructions in the areas exposed to very hazardous risks;
- Compensation of the real-estate exposed to risk by the side of Local Authorities responsible for land use planning.

Moreover additional risk reduction measures at sources could be required. These "additional plans" are elaborated on a local level under the Prefect responsibility, after a public consultation and in partnership with relevant local stakeholders. Once approved by the Prefect, plans are converted into land use planning measures.

Among the various communications and guidelines issued after the emanation of the new law of 2003, one of particular relevance to land use planning is the note *Elements for LUP principles for existing situations derived from the French experience*[300]. The executive summary of the note reads: […] *When introducing the land-use planning article (Article 12) ten years ago, the SEVESO II Directive recognized the necessity to control urbanization both when new installations are authorized and when urban development takes place around existing installations. These two situations appear equally as relevant with respect to situations where urban development takes place around existing installations* (0) *The implementation of a regulation concerning LUP on existing situations with uncomfortable high risks is all the more difficult as it may imply social consequences for people who live in the vicinity of an industrial site. Moreover, acting on existing situations is to be costly* […]"[301].

Among the principles recommended for dealing for developments around existing situations, the main relevant are[302]:

- Priority to risk prevention and reduction of risk at its source:

Any industrial establishment must be, in the present and in the future, compatible with its environment and therefore, priority should be given to risk prevention and reduction at source. Once risk prevention and reduction at source have been assessed and done, societal risk acceptability of the establishment should be assessed before any LUP initiatives.

- Territory concern

Land use planning, especially for existing situations, should clearly state that it applies to a territory or a site that could be called for example a "risk basin". Therefore, several installations or establishments generating risks on the same territory and belonging to the same "risk basin" should be treated at the same time.

- Responsibility of the Competent Authority

The Competent Authority should accept full responsibility in managing the LUP on existing situations development process.

- Stakeholders engagement

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[300] MEDAD (2006), *Elements for LUP principles for existing situations derived from the French experience,* Paris, pp. 27. It is important to notice that the problem of existing situations is one of most complex issues in all European countries. After the accident of Toulouse, the revision of the French legislation focused on this point in particular. This focus was reflected by the contributions provided by the French representatives of the EWGLUP, who divulgated the mentioned note about the principles for land use planning in existing "Seveso" sites.

[301] MEDAD (2006), *op. cit*., at 2

[302] *Ibid*, at 4-7

Risk communication should be promoted either via partnership (bringing together a limited set of relevant stakeholders at work meetings) or via dialogue (bringing together the general public, and enabling information sharing and discussion leading to a better risk understanding[303])

- Full coherence between LUP for future and LUP for existing situations

Action on existing situations should enable to reach the same level of safety as the one that is ensured by action on future situations.

- Balance between actions on the territory and risk reduction at source

The LUP process should facilitate the development of regulatory measures equitable to the various local stakeholders by achieving a cost-benefit balance between territory and risk reduction at source actions.

- Co-ordination of risk prevention policies

The co-ordination of risk prevention policies should be extensively considered, especially in the light of other policies such as emergency planning policies.

At present, a discussion among the members of the EWGLUP about the introduction of such principles among those already recommended in the supporting instruments issued in 2006 is undergoing.

4.2.4 Status of and access to information

After the approval from the side of the involved Authorities, the land use plan *PLU* is submitted to the community's enquiry. Also Safety Reports are accessible to the public. A non-technical abstract, including dangerous phenomena maps, shall be provided to facilitate public understanding of the information therein. The 2003 law allowed the creation of local risk-information committees (Fr. *CLIC*) around top-tier Seveso sites by the Prefect. This committee may call upon the knowledge of recognized experts, in particular to carry out third-party investigations.

It is important to notice that the web-portal of the Ministry of Environment publishes online risk-maps, within which major risks per province and municipality are illustrated. Citizens have therefore direct access to an informative platform wherein the maps of natural and technological risks affecting their municipalities are directly consultable. According to Jones, several schools curricula includes tuition on major accidents, warnings and actions to be taken[304]. In this regard and in consideration of the flows of information improved by the new French regulation about major accidents risk, also by means of the creation of *ad hoc* committees, it may be concluded that the French system guarantees a transparent access to the information related to risks and a good level of participation of stakeholders within decision making processes.

4.3 The Netherlands: the little size of acceptability[305]

In The Netherlands, 138 top-tier and 172 lower-tier establishments were operative at the time of the investigation[306].

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[303] The original document in this part uses the word *appropriation*. For facilitating the reading of the document I decided to replace it with *understanding*.

[304] A. Jones (1997), *op. cit*., at 92

[305] It has to be stressed that during the investigation performed by the Major Accident Hazard Bureau of the Joint Research Centre of the European Commission there was no response to the questionnaire from the side of the Dutch authorities. The country-profile was therefore derived from literature and through the consultation of VROM representatives.

[306] C. Basta *et al* (2008), *op. cit*.

According to the Dutch Ministry of Housing, Spatial Planning and the Environment (VROM), when considering the 500 / 600 refueling LPG stations and the risk due to transport of dangerous substances the number of "risky infrastructures" in the country can be extended up to 4000[307]. Furthermore, the production of chemicals is expected to rise up to double or triple up to 2030 with respect to current levels [308]. In consideration of the high population density of the country, the prevention of consequences of major risk from a siting perspective is therefore central to the national environmental protection and spatial planning policies.

Divided in 12 Provinces and 480 Municipalities, The Netherlands are among the most densely populated countries of the European Union and are well known for being an under-sea level territory for a main part of their extension[309]. The area called *Randstad* (comprising cities as The Hague, Rotterdam and Amsterdam), due to the presence of the main industries and commercial harbors, is the most populated.

In 1953, the southern area of the country (the Zeeland region) had known one of the worst European catastrophic floods of the XX century. Almost 2000 people have lost their lives and enormous damages were reported (Ale 2005). The infrastructural barriers created in response to the event to prevent a second catastrophe absorbed an enormous investment of research, financial and political efforts[310]. The Delta Committee appointed to investigate the catastrophe established quantitative risk acceptance criteria for designing the dykes which should have prevented the consequences of a potential similar disaster, which was provoked by the exceptionally high sea level caused by strong winds. The Committee proposed to realize dykes so high that the sea could only reach the top once every 10.000 years[311]; the probability of the dykes collapsing should have been set at 10 times lower. These recommendations were further converted into law.

Considering the particular geographical position of The Netherlands, their limited territorial extension and the fact that the disaster of 1953, notably, didn't lead to reconsider human settlements in areas subject to flood risk but rather to invest in preventing similar events, "[…] *the Dutch government has committed itself to the concept of risk rather than to the false promise of absolute safety* […]" (Jongejan 2008)[312]. Surely, the country has a long experience in striving for finding a balance between land scarcity, economical development and the defense of a highly vulnerable territory, offering a meaningful example of what could be called "the little size of acceptability".

The matter of risks, their probabilistic nature and the need of setting levels for their acceptance in a cost / benefit perspective entered the Dutch parliament earlier than in other European countries, and established a long tradition of "quantitative-based reasoning" in risk regulation. The first regulations addressing the matter of hazardous installations date back to the Napoleonic Empire the Country belonged to in the XIX century. Differently than in the British

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[307] VROM (2001), *Nationaal Milieubeleidsplan 4: Een wereld en een wil, werken aan duurzaamheid. Een samenvatting*, at 59

[308] *Ibid*, at 17

[309] 486 inhabitants / km^2 in 2008 according to the National Statistic Bureau, online. Information over the population density and growth per year are available at http://statline.cbs.nl/StatWeb/publication/?VW=T&DM=SLNL&PA=37296ned&HD=080424-1838 . Last visited: April 2008.

[310] Information over the flood of 1953 and the developments of the dyke infrastructures falling under the so-called "DELTA project" initiated in the immediate aftermath of the catastrophe are provided, among others, by the *Stichting Deltawerken* (Eng. Foundation Delta Works), online. Available at www.deltawerken.com. Last visited: April 2008

[311] *Rapport van de Delta Commissie* (1957), reported by B.J.M. Ale (2005), *op. cit*.

[312] R. B. Jongejan (2008), *How safe is Safe Enough? The Government's Response to Industrial and Floods Risk*, PhD Thesis, Delft University of Technology, at iii

common law system, wherein controversies are case-based, the Napoleonic legal system implies the definition of laws in which all unlawful or unjust acts are object of definition together with the penalties or compensations applicable to the resolutions of controversies: as a result, many controversies which would see the opposition of private parties in the common law system see the opposition of public *vs*. private parties in the Napoleonic one (Ale 2002: 2005)[313].

Similar to the United Kingdom, regulations addressing the matter of siting dangerous installations and the management of dangerous establishments were enhanced by a series of accidents. Most of them occurred during the 70's; one of the most significant was a catastrophic explosion in an establishment treating propane. The accident killed 14 people in 1975 (Ale 2002: 2005). In the same period, the increase of use of LPG and the relevant storage and transportation problems became object of attention by the side of the Regulator. Investigations concerning the methods applicable to the estimation of the relevant risks were promoted[314].

The acknowledgment of the impossibility of achieving a "0 risk situation" with regard to establishments and transportations involving dangerous substances led to address the first considerations concerning the definition of risk acceptability levels. Considering the legislative background of the country, oriented towards legally binding provisions, a single criterion characterization of risk in terms of probability of fatality (individual risk) and number of deaths (societal risk) of humans was chosen and further enforced in legislations. Similar to the United Kingdom, the acceptable level of individual risk associated to new hazardous installations was set at 100 times less than the risk of being killed in a car accident, specifically at 1 in a million per year or 10^{-6}/year (Ale 2005). For existing situations the maximum acceptable risk is set at a factor of 10 times higher, specifically 10^{-5}/year. For societal risk, the acceptable risk for a number of people > N to die due to a major accident was set at the target value of 10^{-5}/ year[315].

The regulation of the consequences of risk associated to dangerous substances and the relevant spatial planning practice is known in The Netherlands as *external safety*[316]. The corpus of regulations addressing the matter of major accidents risk prevention is collected within the *Publicatiereeks Gevaarlijke Stoffen (PGS)* provided by VROM. Here, the laws and guidelines applicable to the installations and management of dangerous installations together with the transport of dangerous substances are put together in a series of handbooks and reports[317]. Some of them were elaborated by the recently appointed Commission for Hazardous Substances (Dutch *Adviesraad Gevaarlijke Stoffen, AGS*), replacing the previous Commission for the Prevention of

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[313] B.J.M. Ale (2002), Risk Assessment Practices in The Netherlands, Safety Science, No.40, 105-126

[314] Refer in particular to the TNO Report issued in 1983 *LPG: A Study*. Reported by B.J.M. Ale (2005), *op. cit*.

[315] The substantial difference between the qualitative definition of "societal risk" used in the United Kingdom and the strictly quantitative estimation of FN curves required in The Netherlands offers interesting elements for comparison. This will be discussed in Chapter 5.

[316] The External Safety Decree (Dutch: BEVI) entered into force in 2004 gives a detailed definition of external safety (Dutch: *externe veiligheid*) as "*chance of being killed due to an accident due to the presence into an effect area wherein dangerous substances are involved*" (Dutch: "*kans om buiten een inrichting te overlijden als rechtstreeks gevolg van een ongewoon voorval binnen die inrichting waarbij een gevaarlijke stof betrokken is*"). Refer to the text of the Decree: *Staatsblad van het Koninkrijk der Nederlanden, Besluit van 27 mei 2004, houdende milieukwaliteitseisen voor externe veiligheid van inrichtingen milieubeheer (Besluit externe veiligheid inrichtingen),* at 2. Notably *external safety* covers both accidents caused by transport and fixed installations.

[317] These handbooks and reports are accessible via at the website of VROM, available at http://www.vrom.nl/pagina.html?id=20725 . Last visited: April 2008. It has to be noted that some of these handbooks have found application worldwide.

Accidents (Dutch *Commissie van Preventie van Rampen door gevaarlijke stiffen, CPR*) following relevant decision of the Cabinet in 2004[318].

In the same year, a number of considerations on the Dutch risk prevention policy with regard to, among others, electromagnetic fields, stations for mobile communication and societal risk were collected in the document *Dealing with Risks: Solutions for Dealing with Uncertainties* (Dutch *Nuchter Omgaan met Risico: Beslissen met Gevoel voor Onzekerheden*)[319], issued by VROM. Following these considerations, a sound review of the Dutch policy was recommended. These consideration can be reassumed as in the following:

- A risk-free living environment is not achievable: only striving for decreasing risks up to an acceptable level is possible;
- Prevention policies must be based on the possible effects of activities and their chance in consideration, among other factors, of the social perception of risks;
- Activities posing an involuntary risk to society are less accepted than voluntarily taken risks;
- With regard to new developments and activities, prevention is less costly than remediation of damages;
- International agreements shall be considered, with particular regard of European agreements.

Taking into account the provisions stated in the Health Protection Recommendations (Dutch *Gezondheidsraadadvies*)[320] and the 4th National Environmental Plan (Dutch *Nationaal Milieubeleidsplan 4*)[321], the following elements should have been more clearly implemented into risk policies, namely:

- the nature and severity of dangers and risks,
- the possibility and effectiveness of regulations,
- the social perception and acceptance of risks, and
- the cost-effectiveness of regulations.

The Report of RIVM recalled in the communication of VROM individualized four categories of risks, to which several "types of decisional approaches" apply, namely[322]:

- simple, operational decisions related to "simple risks" characterized by limited uncertainty;
- complex decisions related to risks of more complexity and uncertainty, to which high costs are associated. Here, decisions should be based on cost-effectiveness considerations;

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[318] The information is provided in the joint Report recently issued by the Ministries of Environment, Internal Affairs and Water *Publicatiereeks Gevaarlijke Stoffen No. 1, Methoden voor het bepalen van mogelijke schade* (English: *Hazardous Substances Publications Series No. 1, Methods for the Evaluation of Possible Damage*), online. Available at http://www.vrom.nl/pagina.html?id=20725 . Last visited: April 2008. The same publication is available in English under the title *Publication Series on Dangerous Substances (PGS 3, Guidelines for quantitative risk assessment,* also known as "purple book". A downloadable version is available at the above mentioned website.

[319] VROM (2004), *Nuchter Omgaan met Risico: Beslissen met Gevoel voor Onzekerheden*, Den Haag, 30.01.04, at 10. The Report was commissioned to the Dutch Health and Safety Authority RIVM.

[320] Gezondheidsraadadvies, GR-publicatie nr. 2004/03

[321] *Nationaal Milieubeleidsplan 4: Een wereld en een wil, werken aan duurzaamheid, 13 juni 2001, TK 2000-2001, 27801, nr. 1*. It is important to notice that the NMP4 has a strategic relevance to the environmental protection and spatial planning policies of the country, being the time horizon of prescribed principles, objectives and instruments looking at the main environmental national and international challenges up to 2030. Among others, the matter of external safety is explicitly mentioned as a priority field (see the section *"Milieuprobleem 5: Bedreigingen van de externe veiligheid"*, at 16).

[322] VROM (2004), *op. cit*., at 13

- strategic decisions, based on the consideration of the social perception of controversial and uncertain risks. Here, a participatory approach to decisions involving communities should be adopted;
- decisions in conditions of uncertainty, related to risks characterized by a high degree of ambiguity. Here, the principle of precaution should be applied.

One fundamental principle stated in the communication is that a minimum level of protection from the consequences of major accidents shall be guaranteed to citizens and regulated by law[323]. This shall not be interpreted by Operators as the mere compliance with given quantitative thresholds, but as the implementation of the ALARA principle[324].

In the following of the communication, the matter of external safety is further discussed and the main trajectories of the policy developments which would have taken place starting from 2004 are briefly reported. Among them, a better integration of risk evaluations within planning instruments as deriving from the implementation of the Seveso II Directive and a new approach for the consideration of societal risk are mentioned[325]. The latter has been the focus of the review of the Dutch external safety policy initiated in 2004: differently than in the UK, societal risk indexes in The Netherlands do also derive from probabilistic calculation. In so being, they are neither of easy application within planning instruments nor of easy communication to the public.

4.3.1 Operating permit procedure

In the Netherlands, a full QRA is required in the phase of application of permits for the installation of new establishments as well as for the modifications of existing situations. Before 1993, Operators had to submit two different Safety Reports, one to the Ministry of Social Affairs and Employment (Dutch SWZ), responsible for internal safety matters, and one to Provincial or municipal authorities, responsible for external safety management (Jones 1998). After the entry into force of the Environmental Protection Act (EPA), an establishment must obtain a comprehensive license in compliance with all kind of environmental protection requirements (soil, air, noise, etc), among which the risk of major accidents. All hazardous installations (from small LPG stations to large manufacturers of chemicals) must obtain an EPA license in order to operate, within which a cartographic representation of the risk contours associated to accident scenarios has to be provided (Bottleberghs 2000). Depending on the substances treated and the hazards associated to establishments, the Authorities responsible for granting the license may vary from national to local Authorities.

The coordination role for external safety matters has been assigned to VROM, which established the External Safety Directorate as the specific implementation body.

4.3.2 Territorial governance and Dutch land use planning instruments

Dutch public authority is defined as a decentralized state (Dutch *gedecentraliseerde eenheidsstaat*), which means that a decentralization of the competences of government, provinces and municipalities is in place. This three tiers of government having direct responsibility for territorial planning are, according to Dutch constitution, not hierarchically organized: each of them

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[323] *Ibid*, at 14

[324] *Ibid*, at 19

[325] This part of the communication reads: "[...] *At the beginning of 2004 legal provisions for the regulation of risks within planning instruments are given*. (…) *For societal risk, a new framework is developed* [...] (Translated from the original text: "[...] *Begin 2004 wettelijke basis wordt gegeven voor de risiconormering voor inrichtingen en de doorwerking daarvan in de ruimtelijke ordening*. (...) *Voor het groepsrisico wordt een nieuw beoordelingskader ontwikkeld* [..]"). VROM (2004), *op. cit*., at 11

has its own power and competences. Consequently, supervision from one level to the other and consistency requirements based on a geographical scale are in place[326].

The regulatory framework for land use planning[327] is essentially represented by the Spatial Planning Act and the Environment Protection Act issued by the above mentioned Ministry of Housing, Spatial Planning and the Environment (VROM), competent for drawing national policy on spatial planning as well as the official National Policy on Spatial Planning (NPSP) [328]. The latter is a document that is updated once every five to ten years and contains specific aspects of the national policy on spatial planning. It may comprise national structure outline plans, national structure policy sector plans and concrete policy decisions that are of importance to the national spatial planning policy. The SPA prescribes an adoption procedure for the NPSP, including an advice of the State Town and Country Planning Commission, a stage of public consultation and, finally, the adoption by the Parliament.

Under the SPA, Provinces and Municipalities may adopt a Regional Spatial Plan (Dutch *Streekplan*) for the entire area of the province/municipality or for one or more parts in which developments are planned. At local level, three planning instruments are elaborated: the Structure Vision, the Individual Project procedure and the Local Land Use Plan. The latter is legally binding and regulates the use of the land for a period covering up to 10 years. It also the planning document wherein the safety around hazardous installations is regulated.

It is important to notice that the main legal reference for major accidents risk regulation and spatial planning policy is, in The Netherlands, the same: the Environmental Protection Act provides a comprehensive framework for all safety-related and environmental-related matters relevant to spatial planning. Furthermore the NMP4 implementing the Act recalls the matter of external safety explicitly (the so-called "environmental problem 5", Dutch *Milieuprobleem 5*). Differently than in other regulatory contexts, spatial planning has conquered a primary role in the implementation of requirements of the national environmental and, implicitly safety and economical policies. Considering the geographical and demographical characteristics of the country and the necessity of maintaining high economical standards together with acceptable living conditions, this primary role of spatial planning and the advanced state of integration of the matter of risk into planning instruments is not surprising. This integration is made particularly evident by the amount of documents and guidance on spatial planning in at-risk areas, such as the guidance Manual for Spatial and Environmental Planning (Dutch *Handreiking voor Ruimtelijke Ordening en Milieu*) issued by VROM [329]. Here, the regulatory framework for external safety and its

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[326] This information are consultable at the webpage of the Dutch Ministry of Environment and Spatial Planning VROM, online. Available at: http://www.vrom.nl . Last visited: April 2008

[327] The Dutch translation of *land use planning* reads *ruimtelijke ordening*, literally "spatial planning" (*ruimte = space*). The latter definition will be hence used in the following of the country profile.

[328] The Spatial Planning Act (Dutch *Wet Ruimtelijke Ordening, WRO*) in place at the time of the investigation dates back to 1965 (*Wet van 5 Juli 1965 houdende vaststelling van nieuwe voorschriften omtrent ruimtelijke ordening*). Up to 2006, a series of amendments and changes were introduced without reshaping its main provisions and restructuring the spatial planning system. After the approval from the side of the Parliament in 2006, in July 2008 the new Spatial Planning Act will come into force. The changes introduced by the new Act are briefly explained in the English brochure issued by VROM in 2007 *The new Spatial Planning Act*, consultable at the reported web-portal of the Ministry. In general, the spirit of the new Act is facilitating the decentralization of the spatial planning system under the slogan "*local where possible, centrally where necessary*": new procedures enhancing local decision-making processes and a clear distinction between spatial planning policies and their legal implementations at local level are introduced. Considering the fact that at the time of the investigation the Spatial Planning Act in force was the previous one, the description of the Dutch spatial planning system doesn't consider such changes.

[329] VROM (2005), *Handreiking voor Ruimtelijke Ordening en Milieu. Voor Ruimtelijke Plannen.*

implementation in planning instruments is given major relevance together with a detailed account of the criteria to be observed for elaborating planning instruments accordingly.

4.3.3 Systematic method in use for land use planning in risky areas

Until 1993 (hence, before the emanation of the Seveso II Directive) the prevention of major hazards and the protection of population and environment was up to the Nuisance Act. For stationary hazardous activity, a license under the Act was required. This regulation has been replaced with the Environmental Protection Act and, concerning the specific matter of risk assessment, with the Major Accidents Decree (Dutch BRZO 1999)[330] implemented for land use planning by the External Safety Decree (Dutch BEVI, 2004)[331]. As mentioned before, The EPA requires to Operators to obtain a unique license for all the environmental effects it may cause outside its boundaries and that Safety Reports have to be submitted for the other environmental certifications. The Major Accident Decree implements the requirements of the Seveso II Directive with regard to the definition and prevention of major accidents risks, the regulation applicable to the elaboration and submission of Safety Reports[332] and the implementation of the Major Accidents Prevention Policy (MAPP), which is object of a separate and "accessible at the establishment" document[333]. The MAPP document must contain the principles of the prevention policy, namely[334]:

- preventing major accidents,
- ensuring the safety and protection of the health of employees and the public, and
- protecting the quality of the environment.

The External Safety Decree states the criteria for spatial planning in areas subject to major accidents risk. Lessons learned from the accident occurred in Enschede in 2000 are explicitly mentioned in the text of the law[335]. The method used for regulating major accidents risk within spatial planning instruments is not changed in its main elements, among which the most important are (Ale 2002:2005, Bottelberghs 2000):

- the quantification of risk by means of an analytical approach accounting probabilities;
- the evaluation of the individual risk and the definition of thresholds of acceptability;
- the evaluation of the societal risk.

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[330] Refer to the informative circular issued by VROM (1999), *Veiligheidsbeleid voor bedrijven met veel gevaarlijke stoffen. De Seveso Richtlijnen en het besluit risico's zware ongevalle. Het BRZO 1999*. A report over the key-elements introduced by the BRZO was also issued in English by the Committee for the Prevention of Disasters Involving Dangerous Substances (1999), *Report on Information Requirements: Major Accidents Risk Decree '99.* All these reports are accessible via the web-portal of VROM, whose reference was provided before.

[331] Staatsblad van het Koninkrijk der Nederlanden (2004), *Besluit van 27 mei 2004, houdende milieukwaliteitseisen voor externe veiligheid van inrichtingen milieubeheer (Besluit externe veiligheid inrichtingen).* VROM provides additional guidance for the implementation of BEVI in the 7 provinces of the country through the *Regeling Externe Veiligheid Inrichtingen* (REVI), wherein criteria and procedures for calculating risk from different sources are further specified. The REVI was amended 3 times since 2004 until the entry into force of the last version on February 13, 2009. As this occurred during the final revision of this manuscript, the last version of REVI is not included in the country-profile.

[332] It is important to notice that, according to the BRZO and in compliance with the requirements of the Seveso II Directive, Safety Reports must contain both the analysis of risk for people and, as deriving from a separate evaluation, the analysis of risk for the environment.

[333] Committee for the Prevention of Disasters Involving Dangerous Substances (1999), *op. cit.*, at 33

[334] *Ibid*, at 33

[335] *Ibid*, at 18

The last two evaluations involve the calculation and the representation of location-based risk contours and of a societal-risk diagram. For both, legal definitions are given (Ale 2002, Bottleberghs 2000) [336]:

- *individual risk* is the probability that an average unprotected person present at a point around an hazardous installation gets killed consequently to an accident;
- *societal risk* is the probability that a number of people > N gets killed due to an accident caused by an hazardous installation.

The threshold value for individual risk applicable to new installations in consideration of the protection of vulnerable objects is 10^{-6} events / year and it is legally binding (art. 6, 7, 8). For existing situations, the value of 10^{-5} applies. It is important to stress that the main objective and focus of the Decree is on the decrease of the societal risk, being the criterion primarily reflecting the density of population which may be exposed to the consequences of accidents. This is the reason why, the higher the number of people, the stricter the threshold values which shall be observed. Nevertheless, differently than the "stationary risk", the societal risk reflects the *possibility* of the presence of a high number of people and, in so doing, comprises the evaluation of people at risk also due to the presence of, for example, transportation routes in the vicinity of establishments. The rationale of the two criteria is therefore somehow complementary: starting from the assumption that stationary risk for individuals has not to be allowed, a legally binding threshold is provided (Dutch *richtwaarde*); however, in consideration of the high population density of the Country, it is necessary to assess how many people could be exposed to the consequences of accidents also due to their non-stationary presence. Here, a target-value (Dutch *grenswaarde*) is therefore provided. A summary of the threshold values for individual and societal is provided in Table 11:

Table 11 – Dutch individual and societal risk threshold values

Individual risk thresholds	New situations	10^{-6} / year
	Existing situations	10^{-5} / year
Societal target-thresholds	> 10 deaths	10^{-5} / year
	> 100 deaths	10^{-7} / year
	> 1000 deaths	10^{-9} / year

Vulnerability classes for targets are also defined in the External Safety Decree, wherein the criteria to assess several qualitative classes of vulnerable objects (from *a* to *g*) accordingly to the function (private residence vs. public buildings) and permanence of people (houses vs. recreational areas) are provided (art. 1). Houses, hospitals, schools and in general all buildings within which people are either permanently located or considerably numerous are considered "highly vulnerable" and therefore not allowed within the iso-risk contours above the provided

[336] The External Safety Decree gives a detailed definition of both individual and societal risk (art.1). The first is also defined "stationary risk" (Dutch *plaatgebondenrisico*) and corresponds to the provided definition. The definition of societal risk is instead more detailed, and reads: "[…] *the cumulative chance per year that at least 10, 100 or 1000 persons loose their lives as a consequence of their presence in the areas were hazardous effects are provoked by dangerous substances*" (Translation of the original text: "[...] *groepsrisico: cumulatieve kansen per jaar dat ten minste 10, 100 of 1000 personen overlijden als rechtstreeks gevolg van hun aanwezigheid in het invloedsgebied van een inrichting en een ongewoon voorval binnen die inrichting waarbij een gevaarlijke stof, gevaarlijke afvalstof of bestrijdingsmiddel betrokken is* [...].

thresholds. In a simplified form, the individual risk criterion adopted for establishing separation distances can be illustrated as in Fig 12:

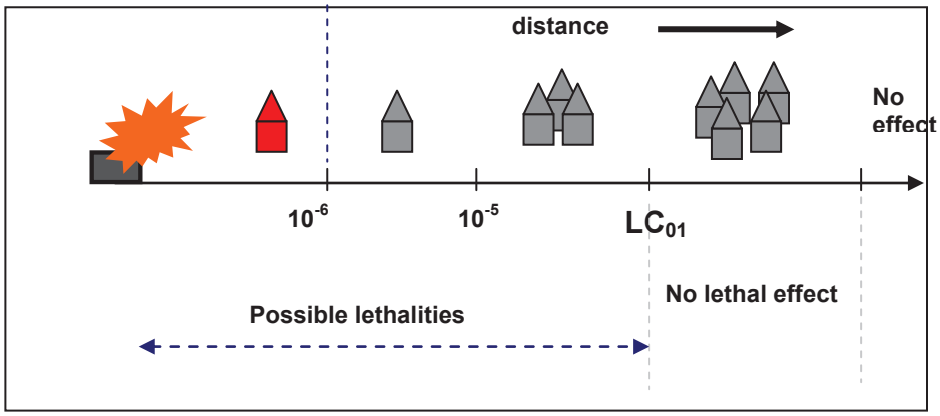

Fig 12 – Dutch individual risk criterion adopted for establishing safety distances (after Bottelberghs 2000)

As shown in Fig 12, the rationale of separation distances is not allowing any individual risk in the iso-risk area where the risk of fatality is of 10^{-6} / year. Iso-risk contours are derived from the QRA provided in Safety Reports. An example is reported in Fig 13:

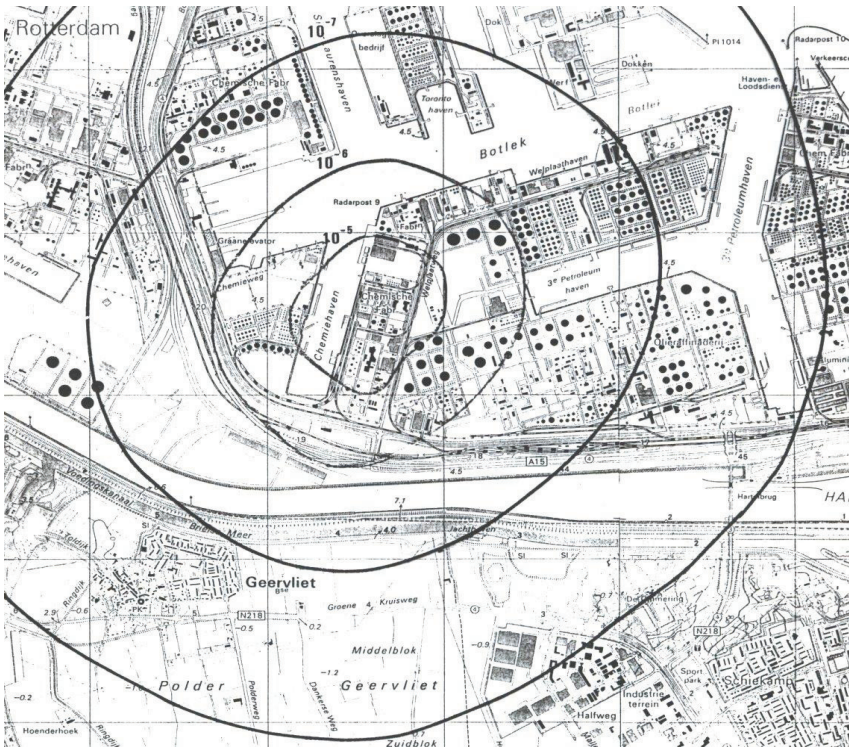

Fig 13 – calculated iso-risk contours resulting from QRA (from Bottelberghs 2000)

As required by the Major Hazard Accident Decree, iso-risk contours are derived from the QRA performed and documented into Safety Reports. Such information is delivered to the local Authorities (Provinces and municipalities) responsible for elaborating planning instruments. Once they are enforced into spatial planning instruments, they therefore acquire the status of publicly available information by means of the consultation procedure in place for the presentation of objections against municipal plans. This information is not comprising industrially protected information or information not relevant to inform the public over the risk of major accidents.

4.3.4 Status of and access to information

In all documents and communications analyzed to compile the Dutch country-profile there is a strong focus on the role of information and participation of the public to all decision making processes "dealing with risks". In the communication of VROM mentioned before and in the Report Risk and Crisis Communication (Dutch *Risico en Crises Gecommuniceerd*)[337] the "citizens right to know" is explicitly mentioned and the promotion of "active communication" among all parties for enhancing the understanding and the acceptance of risks by the side of communities is strongly recommended to Authorities[338]

With respect to spatial planning in areas subject to major accidents risk, planning processes seem to assume to role of the "contexts" within which such participation takes actively place. The Netherlands are among the first European countries who promoted a high level of transparency with regard to the access to geographical information about major risks by the side of the public. Thanks to an initiative of the Ministry of Interior in cooperation with the 7 provinces, an online informative system over the main natural and technological risks relevant to the national territory is in place[339]. Here, risk maps reporting the geographical distribution and the overlap of flood, major accidents and "panic in crowd" risks are directly accessible by the public.

Nevertheless, the information available via the Internet is distilled among those provided to the government by means of Safety Reports. The BRZO Decree establishes which kind of information Operators are compulsory required to submit to the public and which are to be available to the Government only. In the Section "What neighbors will know about your company?" of the mentioned circular issued by VROM[340] it is specified that the list of dangerous substances shall, for instance, be available for the government, but only under specific request to the public, which has to be informed about the risk posed by the establishment, the level of protection in place and all relevant changes in time without having access to confidential or industrially protected information.

4.4 The United Kingdom: a judgmental tradition

In the United Kingdom 360 top- tier establishments and 800 lower-tied establishments were operative at the time of the investigation[341]. The United Kingdom is a constitutional monarchy.

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[337] Voorlichtingsraad (2003), *Risico en crisis gecommuniceerd; naar een verbeterde risico- en crisiscommunicatie*.

[338] VROM (2004), *op. cit*., 24.

[339] Refer to www.risicokaart.nl. Last visited: April 2008. An extensive discussion over the role of risk maps for supporting land use planning processes in the Netherlands, in comparison with the UK, is reported in Chapter 5.

[340] VROM (1999), *op. cit.*, at 5

[341] The inventory refers to the data collected during the last consultation of the EWGLUP representatives in the summer of 2007 and is the same reported in the *Roadmaps*. In order to avoid unnecessary repetitions,

The Parliament issues primary legislation unless devoted to the Scottish Parliament and the Northern Ireland Assembly. Following devolution, the responsibilities of the Secretaries of State for Scotland, Wales and Northern Ireland changed considerably, although they retain their position in the UK cabinet[342].

The country has one of the longest European policy formulation experiences in industrial risk prevention. One of the accidents which prompted the developments of regulations addressing the matter of preventing the consequences of major accidents risk is the accident occurred in Flixborough in 1974. The accident involved the development of an unconfined vapor cloud explosion (UVCE) from a reactor where cyclohexane was oxidized, leading to a catastrophic and completely unpredicted scenario in which 28 persons were killed and incalculable damages were reported in the surroundings (Ale 2005, Lees 1996).

As a consequence of this accident, the national safety agency now known as Health and Safety Executive[343] and the Health and Safety Commission were established. Both bodies are still the primary reference for the health and safety policy and management of the Kingdom. Their centrality in regard and the easily accessible information they provide about the (recently reviewed) method and procedures applicable to land use planning evaluations in areas subject to major accidents risk facilitated the collection of the information reported in this country-profile[344].

An exhaustive analysis of the UK risk prevention regulation has to consider the legislative background of the Kingdom, as well known based on common law. The analysis of the influence of this background on the risk regulatory approach of the country is analyzed by Ale in one of his most recent articles[345].

The form of reasoning used in common law is known as casuistry or case-based reasoning (Ale 2005). Common law (as applied in *civil* controversy, distinct from *penal* controversy) was devised as a means for compensating someone for wrongful acts known as *torts*, including intentional torts and torts due by negligence[346]. Furthermore it was the branch of law recognizing and regulating contracts. Common law principles remain a fundamental reference for the codification of statutes, whereas *codification* is the process whereby a statute is passed with the intention of restating the common law position in a single document rather than creating new offenses. It derives that common law remains the main reference for the interpretation of statutes: all damages traditionally recognized in relation to a given tort may be used to justify sentences, regardless their explicit mention in the current statutory law. The consequence of this tradition-based and non-codified system is an adversarial approach to the disputes over the damages suffered by one or more of the involved parties. The resolution of civil controversies is hence represented, in large majority, by the monetary compensation of damages.

In the context of risk regulation this mechanism results into the reverse consideration of what is reasonable effort to avoid causing damages under certain conditions of risk, being their

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every time I will report quantitative data and / or other relevant information I will refer, unless differently specified, to the information therein collected.

[342] This information are derived from the report commissioned by the Dutch Ministry of Environment over "the state of art" of external safety in selected Countries, VROM (2005) *Legislation on External Safety, Part II*. Consultation under request.

[343] In Ireland, the Health and Safety Executive of Northern Ireland.

[344] Refer in particular to the HSE website at the page: http://www.hse.gov.uk/landuseplanning/index.htm . Last visited: April 2008.

[345] Refer to B.J.M Ale (2005), Tolerable or Acceptable: A Comparison of Risk Regulation in the United Kingdom and in the Netherlands, Risk Analysis, Vol. 25, No.2, pp231-241.

[346] In Roman legal system, from which also the Napoleonic system derives, voluntary torts are defined *dolus* while involuntary torts are defined *culpa*.

occurrence anyway not reducible to 0. These considerations led to the definition of ALARA or ALARP in the UK context and were made explicit by Lord Justice Asquith in 1949 during the reading of the sentence of the case Edwards vs. The National Coal Board[347] The sentence reads as follows: […] *this case established that a computation must be made in which a quantum of risk is placed on one scale, and the sacrifice (whether in money, time or trouble) involved in the measures which are necessary to avert the risk is placed in the other. If it can be demonstrated that there is a gross disproportion between them, the risk being insignificant in relation to the sacrifice, the subject upon whom the duty is laid discharges the burden of proving that compliance was not reasonably practicable* […][348].

This relevance of the ALARP principle to the UK regulatory culture is acknowledged in a number of laws, governmental documents and guidance. The web-page of HSE dedicated to the explanation of the principle reads: "[…] *The concept of "reasonably practicable" lies at the heart of the British health and safety system. It is a key part of the general duties of the Health and Safety at Work etc. Act 1974 and many sets of health and safety regulations that we and Local Authorities enforce. HSC's policy is that any proposed regulatory action (Regulations, ACoPs, guidance, campaigns, etc.) should be based on what is reasonably practicable […]"*[349].

As before explained, the "reasonably practicable" area is the area comprised between a given acceptability threshold and the level of residual risk. In between, the ALARP principle should be adopted to keep reducing risks in a continuous manner, unless a gross disproportion between relevant costs and benefits arises. But how to assess what is "reasonably practicable'?
The two supporting instruments adopted and recommended by HSE's guidance are the *good practice principle* and cost-benefit analysis (CBA). Whereas the first represents the baseline for risk reduction action, the second represents the instrument by means of which risk reduction options can be confronted against a single criterion (i.e. monetary costs). Implicitly, CBA applies in all cases in which "*established good practice does not exist, is out of date or the situation is complex and the relevance of individual good practices is questionable*"[350]. However, "*a CBA cannot form the sole argument of an ALARP decision nor can it be used to undermine existing standards and good practice*"[351]. This was already alleged in the above mentioned guidance *Reducing Risks, Protecting People*, which may regarded as the summary of the UK safety culture and policy: "*HSE believes that such duties* [embodying the concept of ALARP] *have not been complied with if the regime introduced by duty holders to control risks fails the above 'gross disproportion' test. Moreover, HSE believes that in making this compliance assessment, the starting point for determining whether risk has been reduced as low as reasonably practicable, should be the present situation in the duty holder's undertaking. However, in certain circumstances, it will not be possible to assess options in this way. In such situations, the starting point should be an option which is known to be reasonably practicable (such as one which represents existing good practice). Any other options should be considered against that starting point, to determine whether further risk reduction measures are reasonably practicable*"[352]

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[347] Judge Asquit (1949), *Edwards v. the National Coal Board*, All England Law Reports, Vol. 1, pp. 747. Reported in Ale (2005), *op. cit*., at 232. See also the HSE Report (2001), *Reducing Risk, Protecting People: HSE"s decision making Process*, Crown Copyright, London, at 62.
[348] B. J. M Ale (2005), *op. cit*., at 232.
[349] HSE (2008), *ALARP "at glance"*, online. Available at http://www.hse.gov.uk/risk/theory/alarpglance.htm . Last visited: April 2008
[350] HSE (2008), *HSE principles for Cost Benefit Analysis (CBA) in support of ALARP decisions,* online. Available at http://www.hse.gov.uk/risk/theory/alarpcba.htm . Last visited: April 2008.
[351] *Ibid*
[352] HSE (2001), *op. cit*., at 63

In conclusion, the UK approach to risk reduction which can be derived from the guidance of the governmental safety agency is fundamentally a *judgmental* approach: given the principles of ALARP, of *good practice* and the additional instrument of CBA, each case should be evaluated on a single basis. In this regard it is significant that the UK legislation usually provides *target* and not *fixed* acceptability thresholds. The friction between this approach and the regulations decaying from the implementation of European and international regulations is acknowledged by the agency "*this* [the application of ALARP] *may not be possible because the Regulations implement a European directive or other international measure that adopt a risk control standard different from "reasonably practicable" (i.e. different from what is ALARP)*"[353]

This and other aspects of the UK regulation in comparison with the rest of European countries will be discussed in the following Chapter.

4.4.1 Operating permit procedure

The need of establishing a permit procedure for the installations and operation of dangerous establishments was recognized at the time of the works of the Robens Commission, appointed for investigating the disaster of Flixborough. Such procedure resulted in a breach of the common law system, within which, in a simple form, "*every activity that that is not explicitly allowed needs justification*" (Ale 2005)[354]. According to this rationale the "burden of proof" was until then falling under the liability of Operators. Establishing a procedure for granting permits would have shifted part of the burden of justification from Operators to Authorities, in so doing making the latter responsible for eventual damages.

Notwithstanding the doubts expressed by the Commission about the compliance of the operating permit procedure with the common law system, the sitting of new establishments and the modification of existing ones are currently subject to the Hazardous Substances Consent procedure The application is submitted at local level by the Operator to the corresponding Hazardous Substances Authority. HSE is subsequently consulted on the application. HSE advises Local Authorities both on the requirements to be applied to the plant on case of consent (internal safety, operative measures, etc) and on the eventual lack of compatibility with respect to surrounding land use destinations.

4.4.2 Territorial governance and UK land use planning instruments

The general legislation related to land-use planning in the United Kingdom, England and Wales is:

- The Town and Country Planning Act 1990,
- The Planning (Listed Buildings and Conservation Areas) Act 1990,
- The Planning (Hazardous Substances) Act 1990, and
- The Planning (Hazardous Substances) Regulations 1992, as amended by The Planning (Control of Major-Accident Hazards) Regulations 1999.

The last two regulations have implemented the land use planning requirements of the Seveso II Directive. The first three Acts were amended by the Planning and Compensation Act 1991. Due to the devolution of planning functions and decision-making to Scotland, Wales and Northern Ireland since 1997, planning systems in the United Kingdom are diverging from the English model. Scotland and Northern Ireland are using their devolved powers for legislation to develop their own national planning frameworks.

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[353] HSE (2008), *ALARP "at glance"*, *op. cit*.
[354] B.J.M. Ale (2005), *op. cit*., at 233

Nevertheless, the distribution of competences is substantially similar in all countries. Land use planning and urban and environmental management are under the responsibility of Local Planning Authorities. Commonly, Local Plans indicate where land has to be allocated for both human developments and industrial installation. The Town and Country Planning Act 1900 states that Local Plans should consist of "[…] *(a) a written statement formulating in such detail as the local planning authority think appropriate their proposals for the development and other use of land in their area, or for any description of development or other use of such land, including such measures as the authority think fit for the improvement of the physical environment and the management of traffic; (b) a map showing those proposals; and (c) such diagrams, illustrations or other descriptive matter as the authority think appropriate to explain or illustrate the proposals in the plan, or as may be prescribed* […]"[355].

With regard to hazardous installations these plans are evaluated with advice from the Health and Safety Executive. Although the advice of HSE is not legally binding, if proposed developments in the vicinity of hazardous installation are considered to be at risk HSE can apply to the Secretary of State to take over the decisions of Planning Authorities .

After the planning procedure is completed, the adoption of the Local Plan requires the consultation with the public; to this scope, several instruments and experiences (supported by open meetings, public Enquiries, press, etc.) were developed in the last years.

4.4.3 Systematic method for LUP in risky areas

LUP evaluations in the surroundings of plants are carried out by means of the advice provided by the HSE. The Agency establishes "consultation zones" around dangerous facilities falling under the Seveso II requirements and pipelines. Within the consultation zones, HSE has to be consulted for any planning decision.

In 2004, the agency promoted a revision of the methods and procedures in place for providing such advices on the basis of the concerns expressed by Local Planning Agencies about their effective application within planning instruments in consideration of several factors[356]. Though criteria adopted for performing land use planning evaluations remained in line with those set in the general guidance of 1989[357], the Agency reviewed the implementation of the approach together with the advising procedure in consideration of:

- Concerns about the amount of support the HSE would provide when the decision making had been devolved to the LPAs and about whether LPAs would have the resources and IT capability to deal with the work;
- The perception of HSE as a remote counterpart, sometimes difficult to engage on specific planning applications;
- Concerns about "black and white" decisions from the HSE (ie Advise Against/Do Not Advise Against) and the need of additional information for supporting planning decisions.

The dialogue between HSe and LPA's led to reshape the main tool the agency had developed for performing land use planning evaluations, namely the PADHI (Planning Advice for Developments near Hazardous Installations) software. The software is currently available in the version PADHI+,

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[355] *Town and Country Planning Act 1990, Section 36*, "*Local Plans*". The full text of the law is available via the website of the United Kingdom Public Information Service at http://www.opsi.gov.uk/si/si1999/99074303.htm#15 . Last visited: April 2008.

[356] Refer to the series of communications on the "HSE implementation of the fundamental review on Land Use Planning", issued between 2003 and 2006 and available online at the provided agency website. This part refers in particular to the 1st newsletter of May 2003.

[357] HSE (1989), *Risk criteria for land-use planning in the. vicinity of major industrial hazards*, ISBN 0 11 885491 7.

which allows LPA's to carry out evaluations for land use planning autonomously on the basis of the information computed within the tool[358].

The application of PADHI+ to land use planning evaluations is successive to the analysis of risk HSE performs to establish the so-called "consultation distances" (CD), within which the advice for new developments is required. An example of the three zones (inner, middle and outer zone) is reported in Fig 14:

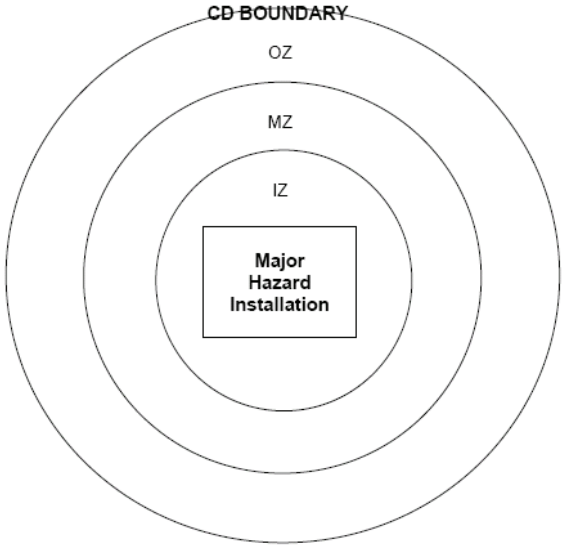

Fig 14 – the consultation zones established by HSE around major hazard installations (HSE 2008)

The methodology developed for establishing CD depends on the specific scenario and substances treated or stored within the establishment. Generally, advices related to toxic releases refer to the risk oriented approach. QRA is applied to "[…] *all foreseeable scenarios and a representative set of events which describe a set of circumstances which, for that installation, could lead to an accidental release of hazardous substances* […]"[359], while in the case of thermal radiation and explosions the consequence-oriented approach is adopted. In the first case, safety distances are assessed against the probability to receive at least a dangerous dose; in the second one, safety distances are assessed against the receipt of prescribed thermal dose units. A dangerous dose is defined as "[…] *a dose which related effects lead to a substantial fraction requiring medical attention; some people are seriously injured, requiring prolonged treatment; any highly susceptible people might be killed* […]" (HSE 2008).

Generally, the criteria used to assess the separation distances between hazards and population are those defined in the 3rd report of the Advisory Committee on Major Hazards of 1984, defining the so called "*protection concept*"[360]. In the Report, separation distances between

[358] HSE (2008), *PADHI – HSE's Land Use Planning Methodology*, online. Available at: http://www.hse.gov.uk/landuseplanning/padhi.pdf . Last visited: April 2008.
[359] Refer to *HSE's current approach to land-use planning,* online. Available at: http://www.hse.gov.uk/landuseplanning/lupcurrent.pdf . Last visited: April 2008.
[360] Advisory Committee on Major Hazard (1984), *Third Report on the Control of Major Hazard.*, Crown Copyright, London, online. Available at: http://consultations.hse.gov.uk/inovem/gf2.ti/f/4194/126469.1/pdf/-/acmh3.pdf . Last visited: April 2004.

hazardous installations and the public are defined as "*a planning decision in those cases where a planning permission is required, and as such is not exclusively a technical matter. (…) Ideally, the separation should be such that the population would be unaffected whatever accident occurs. For hazardous installations, however, such a policy is not reasonably practicable. It seems reasonable to aim for a separation which gives almost complete protection for lesser and more probable accidents, and worthwhile protection for major but less probable accidents* […]"[361].

Following this general concept, recalling the "reasonably practicable" principle, the criteria used to determine the likelihood of incurring the effects of major accidents are both the individual and the societal risk, as illustrated in Fig 15:

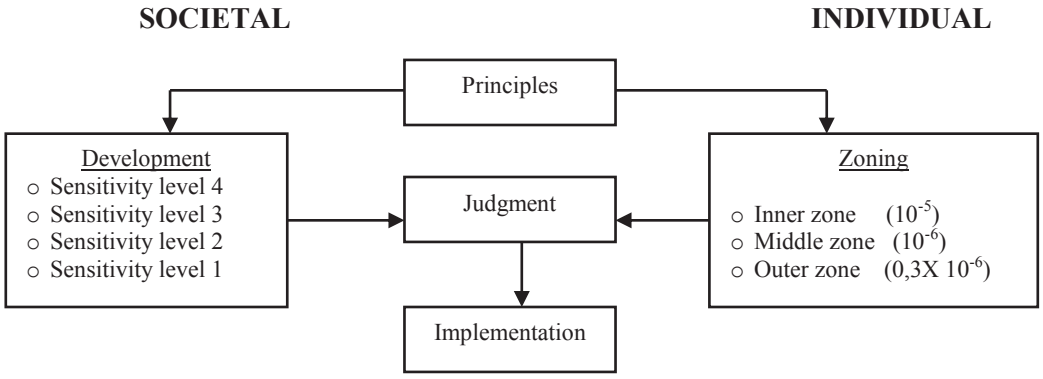

Fig 15 - Societal and individual risk criteria adopted in the UK approach (HSE 2006)

In order to keep a judgmental approach and to evaluate every risky situation in its particular aspects, the calculation of societal risk results from the integration of the individual risk figure with additional population data (HSE 2007). The same judgmental approach is applied to define generic precautionary distances in all cases in which a full assessment is not realizable. However, when a development is proposed within the consultation zones, a full assessment is performed. One decisive element of the analysis is the vulnerability analysis, where the population, the buildings and the infrastructures (generally: the *targets*) are classified using specific indicators. Age of residents, their daily permanence inside buildings and their structural characteristic are the main indicators by means of which four classes of decreasing sensitivity levels (A, B, C and D) are determined, namely:

- Level 1, normal working population;
- Level 2, general public (at home and involved in normal activities);
- Level 3, vulnerable members of the public (children, those with mobility difficulties or those unable to recognize physical danger)
- Level 4, large examples of Level 3 and large outdoor examples of Level 2.

Having determined which sensitivity level falls within which of the three consultation distances, the following matrix is provided for taking relevant planning decisions, wherein DAA stands for Don't Advice Against and AA stands for Advice Against:

[361] Advisory Committee on Major Hazard (1984), *op. cit*., at 20

Table 12 - Compatibility matrix for planning evaluations within the consultation distances (elaboration from HSE 2008)

Level of sensitivity	Development in Inner Zone	Development in Middle Zone	Development in Outer Zone
1	DAA	DAA	DAA
2	AA	DDA	DAA
3	AA	AA	DAA
4	AA	AA	AA

In a simplified form, the advice provided by HSE to the Planning Authorities is based on the above-mentioned standard criteria and methodology, wherein the integration of the three variables of *frequency*, *effects* and *vulnerability* is considered for planning purposes. The 3 zone hazard/risk maps provided by HSE and a matrix approach to support the classification of types of developments by the side of planners allow ready access to HSE methodology. Environmental targets are considered separately, being HSE advice limited to the risk for the public. Besides HSE, Local Planning Authorities consult Environmental Agencies for environmental matters linked to hazardous plants.

4.4.4 Status of and access to information

Differently than elsewhere (like France or Italy) the Safety Report provided by Operators is not a consultable document in the United Kingdom (HSE 2007). Furthermore, risk-maps provided by HSE to Planning Authorities have a restricted access by the side of the public and have to be subject to specific and motivated request to be consulted (C. Basta *et al* 2006)[362]. Nevertheless the COMAH regulation obliges Operators to "*ensure that persons who are likely to be in an area referred to in paragraph (2) are supplied, without their having to request it, with information on safety measures at the establishment and on the requisite behavior in the event of a major accident at the establishment*"[363]. Furthermore, "*every operator of an establishment shall, when requested to do so by the competent authority, provide sufficient information to the authority to demonstrate that he has taken all measures necessary to comply with these Regulations, and the information shall be so provided within such period as the competent authority specifies in the request*"[364].

Land use plans have the status of public documents and public inquiries may be organized for consulting the public over their adoption, including the land use destinations around hazardous installations (HSE 2008). A principle which is strongly embodied by the planning regulation of the United Kingdom is the principle of compensation, according to which planning decisions which are modified or revoked, and which may affect or "render abortive" an investment or causing a loss to third parties, shall be compensated[365]. Information to the Secretary of State and the public about planning decisions (and eventual objections from the side of third-parties) has to be provided by

[362] C. Basta *et al* (2006), *op. cit*.
[363] Statutory Instruments 1999 No. 743, *The Control of Major Accident Hazards Regulations 1999*, Part 5, "Provision of Information to the Public". The full text of the law is available via the website of the United Kingdom Public Information Service at http://www.opsi.gov.uk/si/si1999/99074303.htm#15 . Last visited: April 2008.
[364] *Ibid*
[365] Town and Country Planning Act 1990, *op. cit*., Part IV, "Compensations for Effects of Certain Orders, Notices, etc".

Local Planning Agencies. Publicity in connection with preparation of unitary development plan and local plans is regulated in the Town and Country Planning Act 1990 as in the following *"(1) When preparing a unitary development plan for their area and before finally determining its contents the local planning authority shall take such steps as will in their opinion secure (a) that adequate publicity is given in their area to the matters which they propose to include in the plan; (b) that persons who may be expected to desire an opportunity of making representations to the authority with respect to those matters are made aware that they are entitled to an opportunity of doing so; and (c) that such persons are given an adequate opportunity of making such representation* […][366]. As in the majority of the analyzed countries, planning instruments are therefore the main instruments by means of which the risk of major accidents is communicated to the public.

4.5 Italy: the intermediate choice

In Italy 532 top-tier establishments and 610 lower-tier establishments were operative at the time of the investigation[367]. According to the Ministry of Environment, Seveso establishments are mostly concentrated in the Lombardy Region (242 establishments among which 117 top-tiers establishments), with a general net majority of chemicals and petrol-chemicals establishments (27%) and liquefied petroleum storages (24%)[368].

As extensively discussed in Chapter 2 the name of the Seveso Directives recalls the municipality of Seveso where, in 1976, the first major accident of European relevance occurred. After the unification of the various states of the peninsula under the Kingdom of Italy in 1861 and the proclamation of the Republic in 1947, which followed the Second World War, Italy assumed the current administrative structure. The state is divided 20 Regions, 5 of which administratively independent. A devolution process enhancing the autonomy and legislative power of the ordinary regions took place since the 90's of the last century, mainly by means of the amendment to the 117th article of the Constitution[369]. Currently, Regions can adopt their own legislation concerning the protection of the environment and other general interest matters as civil protection and local economical development. In particular, Regions have a central role with regard to territorial governance. Provinces and municipalities can also adopt regulations with regard to the matters mentioned above; in this case, consistency requirements may apply. Land use planning is consequently performed at 4 different levels according to the National Urban Law[370], which

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[366] *Ibid*, Section 13, "Publicity in connection with preparation of unitary development plan"
[367] C. Basta *et al* (2008), *op. cit.*
[368] Communication of the Ministry of Environment (2006), *Seveso: 1055 Impianti a Rischio in Italia*, online. Available at: http://www2.minambiente.it/Sito/comunicati/2006/09_07_06_1.asp Last visited: April 2008
[369] Legge costituzionale 18 ottobre 2001, n. 3 "Modifiche al titolo V della parte seconda della Costituzione" GU n. 248 del 24 ottobre 2001
[370] Legge 17.8.1942, n. 1150, Legge Urbanistica Nazionale. At the time of the investigation the law was still representing the national legislative framework for Italian spatial planning, notwithstanding a number of sentences of the Supreme Court suppressing a number of articles, in particular with regard to the matter of expropriation and compensation. A number of Ministerial Decrees and other laws issued until recent years introduced a series of new planning instruments (such as regional landscape plans) together with the institutions of so-called "metropolitan areas" and various forms of municipal or provincial coordination. Other Ministerial Decrees are regulating the procedures implementing European Directives, such as the EIA and the SEA. The deregulation following the amendment of the Constitution has further enhanced the autonomy of regions in implementing their own legislations with regard to these procedures. Nevertheless, a comprehensive legislative framework providing the integration of this fragmented corpus of urban and

provides guiding principles and establishes different roles of regional, provincial and municipal authorities. In the Italian general definitions, *regional development planning* refers to the planning instruments performed at regional level, *territorial and coordination planning* refers to the provincial level and *urban planning* to the municipal level. Land use planning refers to the specific land use destinations accorded within urban plans. Each of these tiers of territorial governance elaborates relevant planning instruments, among which those with specific competence for the regulation of the risk of major accidents risk are generally the Plan of Territorial Coordination (It. *Piano di Coordinamento Territoriale*) and urban plans (It. *Piano Urbanistico* or *Piano Regolatore Generale*)[371].

As above mentioned, Regions implement national laws concerning the protection of the environment, the control of major accident hazards and health and safety matters in general. As a consequence, the Seveso II Directive was implemented not only by the Legislative Decree n. 334/99[372] and by the Ministerial Decree 9 May 2001[373] at National level, but also by relevant regional implementations. According to the mentioned laws municipalities shall receive a technical advice provided by a Regional Technical Committee (It. *CTR*) before releasing a building permit in one of the cases regulated by Art. 12 of the Seveso II Directive. The technical permission may be expressed on *ad hoc* basis or during the elaboration of the specific planning instrument prescribed by the Ministerial Decree 31 Maggio 2001, namely the Technical Paper on LUP (It. *Elaborato Tecnico sul Rischio di Incidenti Rilevanti*).

The Ministerial Decree 9 Maggio 2001 is the first legal instrument addressing the matter of land use planning in areas subject to major accidents risk. Before its introduction, urban plans did not include any specific instrument regulating the presence of Seveso establishments within municipal territories. This is the reason why the introduction of the Decree has been preceded and followed by a series of pilot-studies at Provincial and municipal levels[374]

The rationale of the evaluation of safety distances embraces both the concepts of probabilities and consequences, the latter determined according to pre-defined scenarios and given threshold values. Probabilities are therefore a mitigating factor for assessing the compatibility of

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environmental laws is not in place yet. The necessity of a structural revision of the national legislative framework regulating territorial planning at the various tiers of governance is object of a lively debate in the Country, thanks in particular to the influencing National Institute of Urbanism (Italian *INU*) and the various draft-proposals of a new national law the institute issued until 2007. An account of the urban legislation of the country and the introduction of the environmental protection laws starting from 1985 is given by the before mentioned G. Ciucci and G. Muratori (2004), *op. cit*. An overview of the main developments of the Italian legislative framework up to the current revision of the Urban Law is provided by the web-portal of the National Institute of Urbanism, online. Available at http://www.inu.it .Last visited: April 2008.

[371] C. Basta *et al* (2008). *op. cit*

[372] Decreto Legislativo 334/99 in Attuazione della Direttiva 96/82/CE relativa al controllo dei pericoli di incidenti rilevanti connessi con determinate sostanze pericolose. It has to be stressed that the Decree does not include flammable substances such as LPG, regulated in a separate Decree, namely the Ministerial Decree 15/5/96 and the Ministerial Decree 20/10/98.

[373] Ministero dei Lavori Pubblici, *Decreto 9 maggio 2001 - Requisiti minimi di sicurezza in materia di pianificazione urbanistica e territoriale per le zone interessate da stabilimenti a rischio di incidente rilevante*, Supplemento Ordinario n. 151 alla Gazzetta Ufficiale Italiana n. 138 del 16 giugno 2001

[374] Refer for example to the preliminary studies promoted by the Province of Venice in 2003, reported by C. Basta (2003), La Valutazione di Compatibilità Ambientale. Interdisciplinarietà ed intersettorialità: verso una pianificazione integrata, Urbanistica Dossier n.62, INU Edizioni, Rome and C. Basta (2003) I dati significativi sulla situazione di rischio nel territorio provinciale: non solo Porto Marghera, Urbanistica Dossier, n.62, INU Edizioni, Rome.

vulnerable objects, which according to the Decree have to be categorized in 5 classes of vulnerability (from A, maximum vulnerability, to E, clear areas). In this regard, the Country offers an example of a mixed approach: once the consequences of accidents are deterministically assessed, a probabilistic consideration about the opportune land use planning restrictions follows.

Similar to France, relevant evaluations are based on the adoption of a matrix of compatibility, within which the three elements of probability classes, iso-effects areas and vulnerable classes are combined. Differently, and more similar to the British approach, vulnerable objects are categorized by means of quantitative indicators, the rationale of which is "measuring" the more or less easy evacuation of buildings (of which the height and function are therefore considered) and more or less high concentration of vulnerable people (measured by means of, for example, the number of beds in hospitals, children at schools, of people transiting daily on railway tracks, etc). The application of these indicators should therefore lead to a detailed inventory of the various urban targets exposed to the risk of accidents. Furthermore, also the compatibility of environment should be assessed against a quantitative indicator, namely the number of years which might be necessary after an accident to re-establish the *ex-ante* environmental situation. Environmental remediation which might employee more than 2 years of time should be considered incompatible with the risk posed by the establishment. This aspect of the Italian legislation (the strictly quantitative approach adopted for the evaluation of vulnerability of both people and environment) is a characterizing, and problematic aspect of its implementation. Nevertheless, several provincial and municipal pilot-studies performed in the last years demonstrated that the application the method and relevant criteria are flexibly adaptable to the various municipal realities of the Country, characterized by a primary geographical and legislative heterogeneity.

4.5.1 Operating permit procedure

The licensing procedure is carried out by regional authorities for what regard lower-tier establishments and an appointed Regional Technical Committee (It. *CTR*) for what regard top-tier establishments. The latter comprises experts from a variety of bodies, like the Institute for Safety and Protection at Work (It. *ISPELS*) and local Environmental Protection Agencies (It. *ARPAT*). In Italy, a centralized Authority dealing with the licensing procedure is therefore not in place.

Operators of establishments falling under the second category have to submit a preliminary Safety Report to the CTR and must receive its positive technical permission in order to obtain the building permit. The preliminary Safety Report must be elaborated in case of new installations and substantial modifications of existing establishments. The preliminary investigation carried out by CTR is the precondition to obtain the operating permit and land use permissions. The Report must contain the evaluation of compatibility of the risk posed by the establishment with the surrounding urban and environmental context in accordance with the national legislations implementing the Seveso II Directive. Relevant information have to be delivered to provincial and municipal authorities responsible for performing territorial and urban planning instruments.

4.5.2 Territorial governance and Italian land use planning instruments

The devolution of administrative and legislative competences from national to local authorities due to Legislative Decree 31 March 1998 n.112[375] and the successive amendment to the 117th article of the Constitution changed both roles and subjects responsible for territorial governance, following a general objective of enhancing regional autonomy. Regions and provinces have the power to define their own statutes and laws concerning crucial themes as regional

[375] Decreto Legislativo 31 marzo 1998, n. 112, Conferimento di funzioni e compiti amministrativi dello Stato alle regioni ed agli enti locali, in attuazione del capo I della legge 15 marzo 1997, n. 59, GU n. 92, 21 aprile 1998, Supplemento Ordinario n. 77

planning, urban planning principles and criteria, social security, industrial safety and civil protection. The Central Government provides general principles and guidelines as deriving, among other provisions, from the implementation of European Directives.

Due to the sometimes inconsistent political orientations of the different tiers of governance from regional to local administrations and in consideration of the fragmented and heterogeneous character of the Italian territory, the national Urban Laws issued at State level found, historically, a inhomogeneous application in the Country[376]: "*Italy has never had a national plan for land uses*"[377]. This is partially due to the young age of the Republic: Italy is among the youngest European unified states, and the unification of the various kingdoms composing the heterogeneous territory of the peninsula under the Kingdom of Italy was realized only in 1861.

In 1865, the first Law on Expropriation (Italian *Legge sull'Esproprio*) with a national validity was issued by the King[378]. The first national urban law was then issued in 1942, when the country was dealing with the profound political changes which would have led to the proclamation of the Republic in 1947[379]. The law was therefore issued one century from the first national law regulating the overruling power of the State with respect to private properties and territorial planning and after 20 years of fascist dictatorship, in the middle of a war which had dramatically weakened the economy of the country. The first Urban Law established the rules under which municipal plans should have been performed, with particular regard of the criteria for zoning the territory falling under the same municipal administration in homogeneous land uses (agricultural, residential, recreational, etc). The scope of this primitive version of urban plans was essentially assigning property and construction rights and distributing them among the State and private parties[380]. These criteria applied indifferently to all regions and municipalities. Following laws issued between 1968 and 1977 have initiated the process of assignments of territorial competences to Regions and have enriched the original principle of zoning, arriving to the definition of more complex criteria and evaluations for the organization of municipal territories together with the extensions of functions and improvement of integration of land use policies. A particular focus of the Italian urban legislation issued during the '70's, which outcomes are still visible in the majority of cities and metropolitan areas, was the enhancement of construction of residential districts supported by the State. The first laws addressing the protection of the environment, with particular regard of coastal zones and the institution of national protected sites, were issued only starting from the mid '80's (Ciucci and Muratori 2004, Mazza 1997).

After the further strengthening of regional autonomy promoted in the '90's of the last century, the general Italian planning instruments did not change their essential character, but a greater variety of forms of coordination between regions, municipalities and provinces have been introduced. It has therefore to be accounted that profound regional differences are in place. Territorial planning is essentially anchored at municipal level, being the Municipality the authority granting construction permits and defining the wanted infrastructural and land use developments. A consistency between urban plans (Italian *Piano Regolatore*) and regional plans and a coherency with the intermediate level of provincial plans is required. Provinces hold the coordination role for all municipalities falling within their own administration and perform so-called territorial coordination plans. Regions are currently setting the own objectives and regulations for what regard territorial planning, establishing for example the areas of regional interests, subject to particular protection and management, and the regulation of environmental and civil protection.

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[376] G. Ciucci and G. Muratori (2004), *op. cit*.
[377] G. Mazza (1997), *Trasformazioni del Piano*, FrancoAngeli, Milano, at 76
[378] G. Ciucci and G. Muratori (2004), *op. cit.*
[379] G. Mazza (1997), *op. cit.*, at 75
[380] *Ibid*, at 76

Within this administrative structure, Article 14 of the Decree implementing Directive Seveso II addressing the control of urbanization in major accidents risky areas has been implemented by the Ministerial Decree 9 May 2001, concerning the minimal safety requirements for urban and territorial planning. The Decree therefore regulates the matter of Seveso sites at two levels of planning, namely the municipal and the provincial levels. The Decree is further implemented in regional laws. The Decree assigns a primary role for territorial planning with regard to dangerous installations to Provinces, which should act as the intermediate authority between municipalities and regions for, on the one hand, the coordination of local plans and, on the other hand, their consistency with regional laws (Art. 3). In general, the implementation of the Ministerial Decree 9 May 2001 at the various tiers of governance can be summarized as in Table 13.

Table 13 –the Italian framework regulating land use planning in the context of the Seveso II Directive (elaboration from Floridi 2004)

	RISK REGULATION	PLANNING REGULATION
NATIONAL GOVERNMENT	Implementation the Seveso II Directive by Legislative Decree 334/99, further implemented for LUP by the *MD 9 May 2001*	Emanation of the National Urban Law defining principles and objectives of national interest. The Law must be implemented by all the 20 regions and the 2 autonomous provinces.
REGIONS	Adoption of regional laws in accordance with national legislation. Regions must ensure the enforcement of procedures and the assignment of responsibilities as regulated at national and regional levels.	Elaboration of regional plans, wherein planning objectives applicable to provinces and municipalities and contain provisions regarding matters of regional interest are regulated together with the areas of regional interest (parks, historical sites, etc).
PROVINCES	Establishment of the principles for the coordination of measures preventing MA risks in the various municipalities	Elaboration of territorial coordination plans, wherein goods subjected to provincial responsibility (protected areas, transportation routes, etc) are regulated in accordance with regional plans and in consideration of municipal urban plans
MUNICIPALITIES	Elaboration the technical paper on LUP, wherein the risks associated to Seveso establishments and vulnerable elements are represented in a common and easy-reading cartographic base.	Elaboration of urban plans on the basis of the principles and objectives established at regional and provincial levels. The plan is subjected to public consultation after its publication in the Official Journal. Objections can be submitted by citizens during the whole period of consultation established by law.

Within this framework, and in order to enhance the "graft" of risk evaluations within the ordinary territorial planning practice, the Ministry of Infrastructure has developed a specific program for technical assistance to Authorities dealing with the implementation of the DM 9

Maggio 2001[381]. The program includes the appointment of a scientific committee involving representatives from both institutional and non-institutional parties. Several pilot-studies at provincial and municipal levels on the elaboration of coordination and urban plans in accordance with the provisions and criteria established in the DM 9 Maggio 2001 were promoted[382]

It has to be stressed again that the Italian legislative framework, different from countries, is not based on a comprehensive legal reference integrating the various environmental, safety and territorial policy principles and instruments within a general regulation. With the emanation of the 1st amendment to the Seveso II (the Directive 2003/105/EC), within the Italian implementation (Legislative Decree 238/05) the need for guidelines for the implementation of the DM 9 Maggio 2001 was therefore underlined.

4.5.3 Systematic method for land use planning in risky areas

The Italian legislation regulates the matter of dangerous substances in a number of different Decrees referring to different types of substances. For LPG storages and toxic liquids storages specific national decrees have been issued, and a semi-quantitative method for risk assessment is used. The methodology integrates probabilistic elements, applying an index method for classifying the likelihood of pre-selected accident scenarios. Concerning the other dangerous substances regulated by the Ministerial Decree 334/99, a semi-quantitative approach is used to assess both the frequencies of the expected events and the deriving effects. Land use planning evaluations are based on the specific requirements of the Ministerial Decree 9 May 2001, wherein the categories of frequencies and effects are combined with 6 categories of vulnerability in a compatibility matrix, reported in Table 14 :

Table 14 - Compatibility matrix of the Italian MD 9 May 2001

Frequency of the event (classes)	EFFECTS categories			
	Elevated mortality	Mortality	Irreversible damage	Reversible damage
$< 10^{-6}$	DEF	CDEF	BCDEF	ABCDEF
$10^{-4} – 10^{-6}$	EF	DEF	CDEF	BCDEF
$10^{-3} – 10^{-4}$	F	EF	DEF	CDEF
$> 10^{-3}$	F	F	EF	DEF

As shown in the table the criteria used to assess safety distances are those of lethality, initial lethality, irreversible injuries, reversible injuries and material damages. If a vulnerable element (for example: a “B” target, representing a hospital with less than 100 patients) is exposed to a level of risk (frequencies, damages or both) higher than allowed, additional safety measures are

[381] Refer to http://www.infrastrutturetrasporti.it/sites/seveso2/pages/sev_page_05.htm

[382] These studies resulted in a series of publication of sure interest for an insight of the Italian land use planning policy in the context of major accidents risk and provide a detailed overview of the main problematic aspects of its implementation with regard, in particular, to the territorial heterogeinity and political fragmentation of the country. Refer in particular to the handbook issued by the Italian Ministry of Transport (It. Ministero delle Infrastrutture e Trasporti), (2003), *Governo del Territorio e Rischio Tecnologico: Metodologie di Intervento ed Esperienze di Attuazione del DM 9 Maggio 2001*, Rome, pp. 313 (Italian abbreviation *Territorial Governance and Technological Risk*).

required. Vulnerability classes are defined accordingly to a number of indicators, reassumed in Table 15:

Table 15 – vulnerability classes according to the MD 9 Maggio 2001 (after Carpignano *et al* 2002)

CLASS A
1. Residential designate use areas with building landed-index higher than 4,5 m^3/m^2.
2. Places subjected to crowding of people with reduced escape capabilities - for instance hospitals, clinics, hospices, base schools, nursery schools, etc. (over 25 beds or 100 people).
1. Outdoor places subjected to relevant crowding - for instance fixed market or other commercial activities, etc. (over 500 people).
CLASS B
3. Residential designate use areas with building landed-index from 1,5 m^3/m^2 to 4,5 m^3/m^2.
4. Places subjected to crowding of people with reduced escape capabilities - for instance hospitals, clinics, hospices, base schools, nursery schools, etc. (up to 25 beds or 100 people).
5. Outdoor places subjected to relevant crowding - for instance fixed market or other commercial activities, etc. (up to 500 people).
6. Indoor places subjected to relevant crowding - for instance commercial centers, office and services buildings, high schools, University, etc. (over 500 people).
7. Place subjected to relevant crowding, with limited temporal exposure to the risk - for instance public show premises or place for recreation, sport, cultural, religious activities, etc. (over 100 people outdoor; over 1000 people indoor).
8. Railway stations and other transport knots (over 1000 passengers/day).
CLASS C
1. Residential designate use areas with building landed-index from 1 m^3/m^2 to 1,5 m^3/m^2.
2. Indoor places subjected to relevant crowding - for instance commercial centers, office and services buildings, high schools. University, etc. (up to 500 people).
3. Place subjected to relevant crowding, with limited temporal exposure to the risk - for instance public show premises or place for recreation, sport, cultural, religious activities, etc. (up to 100 people outdoor; up to 1000 people indoor; in any case if the frequency of exposition to the risk is at most weekly).
4. Railway stations and other transport knots (up to 1000 passengers/day).
CLASS D
1. Residential designate use areas with building landed-index from 0,5 m^3/m^2 to 1 m^3/m^2.
2. Places subjected to relevant crowding, with at most monthly frequency of exposition to the risk - for instance fairs, periodical markets, graves, etc..
3. Industry, handicraft installations, farms, stock farms and other activities (over100 people).
CLASS E
1. Residential designate use areas with building landed-index lower than 0,5 m^3/m^2.
2. Industry, handicraft installations, farms, stock farms and other productive activities (up to 100 people).
CLASS F
1. Area inside installations boundaries.
2. Neighboring areas, without any building or structure and without usual presence of people.

The rationale of the categorization of the vulnerability of targets and the classification of major accidents scenarios within classes of probabilities and effects is providing minimum safety criteria at national level, enhancing in so doing an homogenous implementation of the Decree in the various regions of the Country. In the transitional period between the emanation of the Decree and its implementation in regional laws, such criteria apply indifferently to the whole Country. The competences of provinces and municipalities in regard are clearly determined: "[…] *Provinces and metropolitan areas, where instituted, individualize within their planning instruments the areas falling under the requirements of the Legislative Decree 334/99. Coordination Plans shall regulate the relation between establishments and territorial / environmental vulnerable objects (...) in consideration of the natural risk individualized in Civil Protection Plans. (...)* (art. 3). *Urban Plans*

individualize, in relation to Coordination Plans, the areas which must be object of specific regulation (...) To this scope, Urban Plans must contain the Technical Paper on Major Accidents Risk […] (Art. 4)[383]

Furthermore, the application of the provided indicators shall facilitate the inventory of municipal territories and the realization of "vulnerability maps" like the one represented in Fig 16:

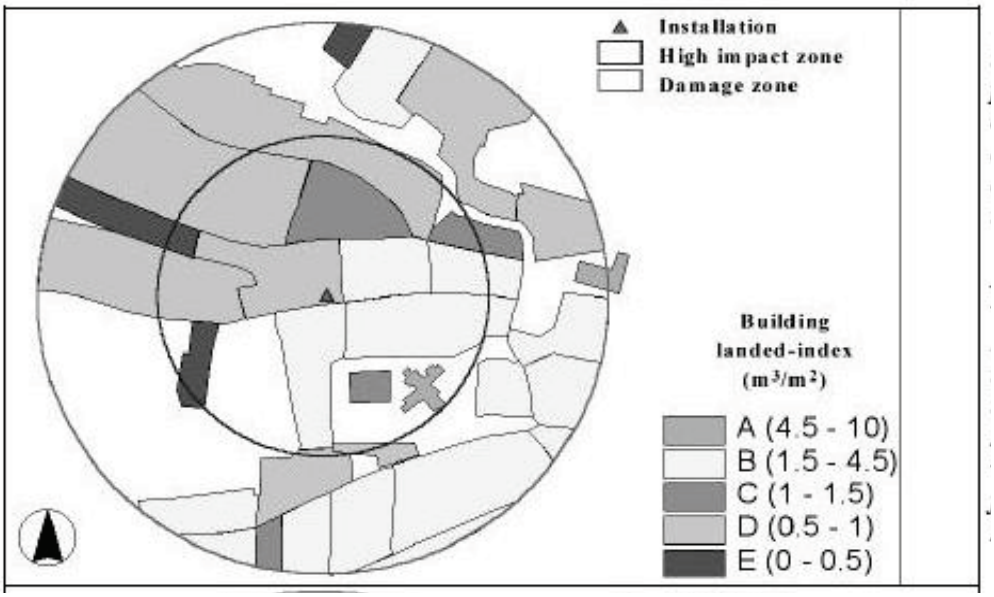

Fig 16 – example of vulnerability map according to the indicators provided by the DM 9 Maggio 2001 (from Carpignano *et al* 2003)

As above reported the regulation of "specific cases" like the one represented in the figure falls under the responsibility of municipalities, which grant building permits in accordance to the three cases disciplined by the Seveso II Directive and the relevant national implementation. Similarly than in France, such regulation is reported in a comprehensive document collecting all establishments present in the territory falling under the same municipal administration, the mentioned Technical Paper on MA risk. Its elaboration is carried out my municipalities according to three phases (paragraph 5 of Annex 1 of the DM 9 Maggio 2001):

- Phase 1: individualization of territorial and environmental vulnerable elements according to the information provided by Operators, the indicators provided in the Decree and the information at disposal of municipalities deriving from the monitoring of the territory. This data are to be represented in a up-to-date cartographic basis;
- Phase 2: determination of effects areas associated to Seveso installations and, where applicable, the determination of their probability accordingly to the kind of substance and scenario in accordance with relevant Decrees. This information are to be represented on the same cartographic basis;
- Phase 3: evaluation of compatibility between the effects areas and vulnerable elements accordingly to the compatibility matrix provided by the Decree. The evaluation should consider the eventual exposure of relevant areas to natural and hydro-geological risks.

[383] Refer to the text of the DM 9 Maggio 2001.

In case of incompatibility, municipalities shall proceed with the acquisition of information from Operators concerning the additional measures aimed at decreasing risk. In the Decree there is hence no mention of the measures municipalities may take to decrease the vulnerability of the exposed areas.

An interesting element of the Italian legislation is the integration of the matter of environmental vulnerability (and therefore compatibility) within the same evaluation aimed at establishing safety distances between hazardous installations and the population. Though "*the evaluation of natural vulnerability, as defined in the Ministerial Decree 9 May 2001, has been showing some problems during its implementation, and further studies are currently under development*"[384], the criterion proposed for evaluating the vulnerability and compatibility of environmental targets is worthy of some reflections.

Following the application of the Decree 9 Maggio 2001, environmental targets should be considered within the Technical Paper on MA risk. Their vulnerability to the exposure of dangerous substances should be therefore assessed. The proposed criterion refers to the estimated time which would be more likely necessary to re-establish the conditions of an environmental target (such as a protected site, underground water, etc) in place before the occurrence of the accidental event (paragraph 6.3.3 of Annex 1 of the DM 9 Maggio 2001). Following this consideration, two categories of environmental damage are defined:

- Significant damage: the restoration of the original environmental conditions are likely to employee a period of time < 2 years;
- Serious damage: the restoration of the original environmental conditions are likely to employee a period of time > 2 years.

In the second case, the risk posed by the establishment is deemed too high and additional safety measures by the side of Operators, together with additional preventive measures within urban planning instruments, shall be required[385].

Both for LPG storages and dangerous substances, the thresholds values of the adopted criteria are legally binding and must not be exceeded in any case. This applies also to the classification of targets within the regulated vulnerability classes. This strictly quantitative approach requires to planning authorities to monitor the development of the urban areas exposed to the risk of accidents on a constant basis, and represents a clear incentive for measures decreasing the risk at source.

4.5.4 Status of and access to information

A limited version of Safety Reports (with the exception of industrially protected and information relevant to national security) is available to the public under specific request. As in the

[384] C. Basta *et al* (2008), *op. cit*.. The text mentions the written contribution of the Italian delegation of the EWGLUP to the investigation collected in the *Roadmaps* document.

[385] It is important to notice that the "time criterion" proposed by the DM 9 Maggio 2001 is rather innovative, but indeed of difficult application: the *ex-ante* evaluation of the time needed to restore the conditions of the environment in place before the occurrence of an accident is strongly depending on the type of environmental target (superficial water rather than a protected oaks park), the substance involved and the economical and technical efforts required to clear polluted areas. Here, the Ministerial Decree doesn't indicate the actors liable to afford the costs of such operations. Furthermore the Decree doesn't provide any further indication concerning the "additional preventive measures" the planning instruments should integrate in order to "decrease the expected environmental damage". On the other hand, it is important to stress again that the scope of the Decree is providing minimal safety standards applicable to the whole country, highly heterogeneous in terms of environmental, historical and social characteristics. Nevertheless, further legislative developments at national level with regard to this problematic aspect of the application of the Decree are expected in the forthcoming years.

majority of European countries, the information related to the risk of major accidents are therefore available mainly by means of the public status of planning instruments, which are subject to a mandatory period of public consultation after their publication in the Official Journal of the Republic.

An inventory of dangerous establishments falling under the requirements of the Seveso II Directive and the relevant national implementation is published by the Ministry of Environment and updated every six months. Here, iso-risk or iso-effects contours are not reported.

4.6 Germany: the deterministic tradition

In Germany 979 top-tier and 976 lower-tier establishments were operative at the time of the investigation[386]. As well known the country is a federation consisting of 16 States or *Länder*. The relation between the national federal administration and the states is regulated within the so-called ´basic law' (German *Grundgesetz*). It is important to remind that all States have their own Constitutions and are represented in the Federal Parliament. Eight of these *Länder* are divided in smaller *Bezirke* while all of them are divided in *Kreiser*, corresponding to the regional authorities. This is the reason why compiling a comprehensive overview of the major accidents and land use planning policies of the country presents more difficulties than for other, more centralized nations. In this section only general information, mostly referring to the legislation issued at federal level, is therefore reported[387].

Land use planning in Germany is regulated within a number of statutes at federal and state level. The principle established in the German constitution has had a strong influence in the development of the European environmental policy (Adams 2002). The precautionary principle originates in the '70's in Germany as *Vorsorgeprinzip* and was originally formulated as "the principle of taking care before acting"[388]. The polluter-pays principle (*Verursacgerprinzip*), the proportionality principle between costs and gains (*Wirtschaftliche Prinzip*) and the common burden principle (*Gemeinlast Prinzip*) were also constituting the basis of the German constitution before being discussed, and eventually adopted, at European level.

The influence of these principles into German environmental policy is still relevant and shaped the environmental and industrial policies orientation of the Country (Boehmer-Christanses 1994, reported by Adam 2005). With respect to the matter of risks posed by technologies, as already discussed the strict meaning of "*pre*-caution" corresponds to "risk-avoidance" and, implicitly, to aiming at realizing 0 risk situations. Nevertheless, the interpretation of the *Vorsorgeprinzip* in German policy "*becomes a metaphor for a wide-ranging industrial and economic strategy*"[389]. According to the Author the principle has therefore driven the developments of corollary principles and strategies for risk prevention rather than promoting a "0 risk mentality".

Nevertheless, the corpus of principles stated in the Germans constitution are a possible explanation of the historical deterministic orientation of the legislation regulating the risks posed by dangerous industries and, successively, of the opposition of Germany to the adoption of a probabilistic orientation at European level. Furthermore, coherently with the analysis of Boehmer-

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[386] C. Basta *et al* (2008), *op. cit*.

[387] The difficult collection of information whit regard to Seveso installations, associated risks and land use policies due to the decentralized structure of the Federal Republic of Germany is acknowledged also in the work of Jones, to my best knowledge one of the most detailed European comparative studies in the field of major accidents regulations. Refer to A. Jones (1997), *op. cit*., at 145

[388] M. Adams (2002), *op. cit*., at 303. the Author further specifics that the prefix "*vor*" translates "before", the word "*sorge*" translates "care".

[389] Boehmer-Christiansen 1994, reported by M. Adams (2005), *op. cit*., at 303

Christanses, it may explain the strong relevance of the BAT principle (Best Available Technology) to the regulation addressing the prevention of consequences of accidents. The rationale behind the principle is in fact that, once the best available technology is implemented by Operators *in situ* and a deterministic approach is adopted to regulate the vicinity between hazardous installations and population, the residual risk is theoretically reduced to a negligible level.

Recommendations for separation distances between residential areas and potentially polluting activities are in place since the late '70s. The aim of these regulations was preventing serious nuisances or hazards in the neighbourhood of establishments due to noise or air pollution. At present, regulations implementing the requirements of the Seveso II Directive are part of the Federal Pollution Protection Act, which applies to the whole Country[390].

4.6.1 Operating permit procedure

The Federal Pollution Protection Act (German acronym *BImSchG*) provides the rules for granting licenses for potentially polluting or hazardous installations or activities according to the Annex of the 4th Ordinance for the Implementation of the Federal Pollution Protection Act 4 (German acronym *BImSchV*)[391]. The implementation of the requirements of the Seveso II Directive is then up to the 16 *Laender*. Some general aspects are anyway harmonizing the procedures in all States (Jones 1998). The licensing procedure includes the granting of the Building Permit and the compliance with the spatial planning legislation. An application for a license may be refused if the consequences of risks associated to the establishment are deemed to high for the surrounding population and / or incompatible with the desired land uses. The tolerability of risks under the German Major Accident Ordinance is governed by the concept that *"establishments may only carry out their hazardous activities if they are able to demonstrate that hazardous effects from an accident may be reasonably excluded"*[392]. This implies that the operating permit procedure, as well as land use planning in the surrounding of establishments, is based on the evaluation of the consequences associated to accident scenarios, without any explicit consideration of probabilities of relevant events. The "state of art of safety technology" principle has a strong accent in federal as well as national legislations, reason for which the licensing procedure "*focuses on the hardware side of safety*" (Jones 1997)[393].

4.6.2 Territorial governance and German land use planning instruments

Spatial planning in Germany is regulated at the various tiers of governance, starting from the laws applicable to the Federation down to the legally binding land use plans elaborated at municipal level. Considering the decentralized structure of the Federation it is rather difficult to give a comprehensive overview of the various levels and differences of land use planning policies in the whole country. Nevertheless, Federal law is a primary legislative reference and most of the environmental and safety-related national legislations decay from the Acts issued at Federal level. It is important to notice that such references provide objectives and guidance applicable to the Federation, but that legally binding planning instruments are issued from state to local levels only[394].

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[390] Abstände zwischen Industrie- bzw. Gewerbegebieten und Wohngebieten im Rahmen der Bauleitplanung und sonstige für den Immissionsschutz bedeutsame Abstände (Abstandserlass), MBl. NW. 1998, P. 744

[391] Vierte Verordnung zur Durchführung des Bundes-Immissionsschutzgesetzes (Verordnung über genehmigungsbedürftige Anlagen -4. BImSchV), 14 March 1997, last amended in 15 July 2006.

[392] C. Basta *et al* (2008), *op. cit.*

[393] A. Jones (1997), *op. cit*., at 141

[394] Refer to the Reports issued in 2001 by the Committee on Spatial Development in the Baltic Sea Region, in particular the *Compendium of Spatial Planning Systems in the Baltic Sea Region: Germany*, online.

The Spatial Planning Act (Germ. *Raumordnungsgesetz, ROG*)[395] is the federal legislation which regulates land use planning principles at national level and defines the coordinates that states and other public bodies should follow when carrying out spatial planning at regional and local level. The Federal Building Code (Germ. *Baugesetzbuch, BauGB*)[396] is the federal legislation which defines in detail the procedure for carrying out land use planning from the regional level down to the detailed urban planning. The classifications of the type of use for which an area may be designated within the urban plan are defined within the Federal Land Use Ordinance (Germ. *Baunutzungsverordnung*, acronym: *BauNVO)*[397]. This legislation provides the framework for the German "zoning principles" which are applied in the land-use planning since the '50s. The sixteen states have the responsibility to take the goals and principles defined at the federal level and turn them into spatial development aims for state and regional planning. This is carried out via the *Landesplanungsgesetz* (Germ. acronym LplG) of the individual States. The states are also responsible for the coordination and approval of public and private infrastructure with wider ranging spatial relevance, e.g. airports and major transportation routes.

The central planning competence in Germany is anchored at the local level. Here several types and hierarchies of planning exist. The municipalities are obliged to formulate two types of statutory land use plans. The preparatory land use plan (Germ. *Flächennutzungsplan*, Scale 1:5000 to 1: 15000 according to the area of the municipality) constitutes a framework instrument, while the legally binding land-use plan (Germ. *Bebauungsplan*, scale usually 1:1000) serves as a regulatory instrument. The preparatory land use plan covers the entire area of the municipality and indicates the intended development of the community. It is binding for all public bodies; private actors are neither bound by it nor can they base any claims for building permission on it. The legally binding land use plan is more detailed, defines functions and density of land uses and the positioning and design of public infrastructures. This legally binding land use plan is therefore a follow-up of the preparatory land use plans. Environmental aspects are an important consideration together with public safety. Land use plans usually determine which kinds of land uses are permissible in the respective parts of a town to which the plans apply (e.g. industrial areas, areas for various kinds of uses like housing and trade, areas purely or predominately reserved to housing, etc). The legal provisions dealing with spatial planning at different levels (national, state, and local) need to be strictly distinguished from State laws which are regulating safety and construction regulation of buildings. Land use planning in relation to risk prevention is regulated more at the level 2, 3 and 4 (States and municipalities), and particularly in the legally binding land use plans elaborated by municipalities. In summary, the different levels and competences for land use planning can be listed as in Table 16 and 17.

Available at: http://vasab.leontief.net/countries/germany.htm . Last visited: April 2008.

[395] Raumordnungsgesetz (ROG) vom 18. August 1997 (BGBl. I S. 2081, 2102), zuletzt geändert durch Artikel 10 des Gesetzes vom 9. Dezember 2006 (BGBl. I S. 2833), online. Available at http://www.gesetze-im-internet.de/bundesrecht/rog/gesamt.pdf . Last visited: April 2008.

[396] Baugesetzbuch (BauGB) in der Fassung der Bekanntmachung vom 23. September 2004 (BGBl. I S. 2414), zuletzt geändert durch Artikel 1 des Gesetzes vom 21. Dezember 2006 (BGBl. I S. 3316). *Ibid*

[397] Verordnung über die bauliche Nutzung der Grundstücke (Baunutzungsverordnung - BauNVO) in der Fassung der Bekanntmachung vom 23. Januar 1990 (BGBl.1 S. 132), zuletzt geändert am 22. April 1993 (BGBl.1 S. 466), online. Available at: http://www.bauarchiv.de/neu/baurecht/baunutzungsverordnung/baunvo_main.htm . Last visited: April 2008.

Table 16 - Competences for spatial planning at various tiers of government (Adapted from: NOFDP 2007)[398]

	Tier of governance	Competences
1	Federation	• Legislation for federal spatial planning (Germ. *Raumordnung*); • Legislation for local planning
2	Federal State (Germ. Bundesland)	• Legislation for national spatial planning (Germ. *Landesplanung*), including sub-regional planning (Germ. *Regionalplanung*) • Elaborationof State Development Programme (Germ. *Landesentwicklungsprogramm*) • Legislation on State Building Code (Germ. *Landesbauordnung*)
3	Regional and sub-regional	• Elaboration of sub-regional plan State Development Programme (Germ. *Regionalplan*), coordinating state and local development policies
4	Municipal	• Elaboration of land use plan (Germ. *Flächennutzungsplan*) indicating the intended spatial development for the municipal territory; • Legally binding local plans (Germ. *Bebauungspläne*) for limited areas to be evolved from land-use plan

Table 17 - Competences for spatial planning at various tiers of government: planning instruments and their description (Adapted from: NOFDP 2007)

Tier of governance		Responsible body	Planning instruments	Description
1	Federation	Federal Ministry of Transport, Building and Urban Affairs	1.Spatial Organization Act 2. Federal Town Planning Act 3. Land Use Ordinances 4. Map sign Ordinances 5. Special Provisions for development and urban renewal	1.Basic goals of principles of countries; spatial organization taking account of European Union spatial policy and setting a framework for the States 5.Legal regulations affecting local plan: types of plans, range of potential contents, procedures and citizen participation
2	Federal States	Ministries of State Parliament	1.State Planning Act 2.State Development Programme 3. Design Guide Ordinance 4. Sate Building Code 5. Approval of Local Planning	1.Laws for regional and sub-regional planning 3.General guidelines for sub-regional and local planning
3	Municipality	- Local Authorities - Council Development control office	1.General Land Use Plan 2.Detailed Development Plan	1.Preparatory plan covering the municipality and defining main lines for future urban developments 2. Local plan to which all buildings and developments have to conform.

[398] NOFD (Nature-oriented flood damage prevention), *Description of the German Spatial Planning System*, online. Available at http://nofdp.bafg.de/servlet/is/13222/?lang=en, last visited: July 2007.

4.6.3 Systematic method in use for land use planning in risky areas

In 2005 the Guidance *SFK/TAA-GS-1*[399] was published jointly by the German Hazardous Incidents Commission (German *SFK*) and the German Technical Committee for Plant Safety (German *TAA*)[400]. The Guidance gives recommendations for separation distances between establishments under the German Major accidents Ordinance (German *Störfall-Verordnung*)[401], and provides the principles for land use planning in areas subject to major accidents risk.

The implementation of Article 12 of the Seveso II Directive are defined in the mentioned Federal Building Code (German *BauGB*) together with the associated Federal Land Use Ordinance (German *BauNVO*) and in Section 50 of the Federal Pollution Protection Act. Art 12 is therefore primarily implemented at federal level. Separation distances should: […] *ensure that the effects of major accidents surrounding sensitive objects are avoided as far as possible* […]"[402]. Such recommendations are only related to people as the subject to be protected and are not applicable to existing situations or as the basis for the external emergency planning. Probabilistic risk assessment as carried out in The Netherlands and the UK does not have an equivalent use in Germany. According to the mentioned Guidance the main reason for this is that the establishments which fall under the requirements of the Seveso II Directive in Germany are required to be installed and operated according to the principle of State of the Art in Safety Technology; the rationale of a strict implementation of this principle is that the risk of consequences of accidents outside establishments is negligible.

The method generally used for assessing separation distances between establishments and surrounding areas in the various states of the Federation is consequence-based. In exceptional cases different methods are applied, e g. probabilistic assessment (with certain conventions, like the pre-selected scenarios) or a case – by – case approach (e.g. for existing situations). The consequences-based approach is based on pre-selected "worst credible" or "most representative" scenarios. With respect to fertilizers (ammonium nitrate) and explosives generic approaches are occasionally used, while in the case of LPG applicable standard scenarios (like the BLEVE) are adopted. In any case, the evaluation of safety distances in correspondence to the "worst credible scenario" is based on the maximum permitted amount of substance, its temperature and pressure.

The mentioned Guidance of the SFK/TAA commission provides recommendations for separation distances in the two cases of "without knowledge" and "with detailed knowledge" evaluations. In the first case, a series of pre-selected worst scenarios and relevant fixed-distances are provided for explosives and ammonia nitrate, both regulated by relevant laws[403]. For all other substances, pre-selected scenarios and end-point values for physical effects under pre-defined dispersion conditions are provided. The case of "detailed knowledge" applies to existing situations in which new developments are to be evaluated in the vicinity of establishments about which licensed substances and their quantities are already known. In case the separation distances from

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[399] SFK/TAA-GS-1 (2005), *Recommendations for separation distances between establishments under the Major accidents Ordinance and Areas requiring protection within the framework of Land-Use Planning, Implementation of § 50 Federal Pollution Protection Law (BImSchG),* online. Available http://www.kas-bmu.de/publikationen/sfk_gb/sfk-taa-gs-1k-en.pdf (short Version). Last visited: April 2008

[400] The SFK and the TAA were set up pursuant to Sections 31a (repealed) and 51a of the Federal Pollution Protection Act under the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. In November 2005 SFK and TAA merged together to form the Commission on Process Safety (Germ. *KAS*).

[401] Zwölfte Verordnung zur Durchführung des Bundes-Immissionsschutzgesetzes (Störfall Verordnung - 12. BImSchV), 26.04.2000, online. Available at:
http://www.gesetze-iminternet.de/bundesrecht/bimschv_12_2000/gesamt.pdf . Last visited: April 2008.

[402] SFK/TAA-GS-1 (2005), *op. cit*., at 2

[403] Namely, the Explosive (Spreng) and Hazardous Substances Ordinance (*Gefahrstoff-Verordnung*). Refer to SFK/TAA (2005), *op. cit*., at 3

proposed developments are less than those recommended for the previous case, than the analysis of the specific case must be carried out.

The SFK/TAA-Recommendations are guidance and the provided endpoints (German *Toleranzwert*) should be considered as target-criteria[404]. Their application is left to the individual State and the executive authorities at regional and local level, which, where justified, may adopt other values. With respect to the natural environment, the acceptability of risks associated to Seveso sites is assessed in the context of the Environmental Impact Assessment procedure.

4.6.4 Status of and access to information

Regional and Local Authorities are responsible for the whole procedure of siting dangerous installation and relevant planning decisions, with the Municipality as final decision-maker. On the level of the *Bauleitplanung* (i.e. land use planning performed at municipal level) an intensive public participation in two phases exists. It derives that the public is consulted also on planning decisions with regard to hazardous installations. The first phase of the public participation on the basis of the Federal Building Code means early involvement of general public and participation of public agencies and of neighboring municipalities. In the second phase (so-called "formal public participation") the draft plan is placed on public display. Any member of the public is entitled to inspect the plan and to make suggestions or raise objections. The way objections have to be handled during the phase of formal public participation is regulated in detail by the Federal Building Code. Essentially, municipalities are obliged to examine carefully all presented arguments. If the municipality does not accept the arguments behind suggestions and objections, it is required to submit these to the higher administrative authority. In addition, the FBC requires participation by Public Agencies. Municipalities shall obtain comments and opinions from public authorities and from other public agencies whose activities are affected by the planning measure at the earliest opportunity.

[404] SFK/TAA-GS-1 (2005), *op. cit*., at 3

ANNEX 1

TWG5

QUESTIONNAIRE

Purpose

Objective 1 of the Technical Working Group on Land-Use Planning requires the Group to "*Give the principles of "good practice" in Land-Use Planning and describe the underlying principles of risk/hazard assessment that will support this (e.g. consistency, transparency, robustness, etc)"*. In order to deal with this objective in a more operational way and to collect information on the current status of "good practice" within the Member States, this Questionnaire was developed. The questionnaire should be completed by the experts of the Plenary Group or by the Competent Authorities. It is up to the responders to do this based entirely on own knowledge or to gather the information also from other bodies, e. g. planning authorities or regional/local authorities.

1. Data of the responder to the Questionnaire:
Name:
E-mail:
Organisation:
Country:
Type of authority: EWG-LUP expert / Competent Authority

2. Is a systematic hazard/risk assessment method for industrial hazards in the context of Land Use Planning used in your country (either on national or on regional/local level)?

- ☐ Yes
- ☐ Some regions/municipalities
- ☐ No
- ☐

If No, what is the basis for answering the "Methodology" Section of this Questionnaire*?*

- ☐ Internal discussions possibly leading to the adoption of the methodology suggested
- ☐ Personal opinion
- ☐ Official working group opinion preparing a methodology

A. Methodology for Land Use Planning

A1. What hazard/risk assessment method are you using in your Country? (multiple answers possible)

- ☐ Full probabilistic (many accident scenarios – chosen case-by-case - quantifying both frequencies and consequences and basing decisions on their combination)
- ☐ Probabilistic with certain conventions (pre-selected scenarios)
- ☐ Consequence-based (worst case scenario)
- ☐ Consequence-based (pre-selected 'worst-credible' or 'representative' scenarios)
- ☐ Semi-quantitative method (please give details)
- ☐ Generic approach (pre-selected scenarios for plant categories)
- ☐ Generic distances, not calculated individually
- ☐ Case-by-case
- ☐ Other (please explain)

A2. Is there a combination of generic approaches and specific assessments?

- ☐ Generic approaches are generally used. No specific assessment permitted
- ☐ Generic approaches are generally used. Specific assessment is sometimes permitted. (spec. when):
- ☐ Generic approaches are occasionally used. Specify when:
- ☐ Generic approaches are never used. Always a specific assessment is required.

A3. What effects of major accidents have been chosen as criteria in order to assess the acceptability (tolerability) of Major Accident Hazards?

- ☐ Individual/ Societal Risk
- ☐ Acute (short-term) fatalities
- ☐ Total number of fatalities (Acute + Latent)
- ☐ Number of Fatalities and Injuries
- ☐ Injuries of large number of people
- ☐ Material Damage
- ☐ Other (please describe)

A4. What respective hazard/risk levels (endpoints) have been chosen as criteria in order to assess the acceptability (tolerability) of major accident hazards? Which values have been adopted?

- ☐ Individual risk of fatality Value:
- ☐ Both Individual and Societal Risk of fatality Values:
- ☐ Individual Risk of receiving a dangerous dose or worse Value:
- ☐ Effects – toxic Value:
- ☐ Effects – thermal radiation Value:
- ☐ Effects – overpressure Value:
- ☐ Material damage Value:
- ☐ *Other (please describe)*

A5. Please specify how effects to the environment are included into the assessment of the acceptability of Major Accident Hazards?

A6. Do less strict values apply for existing situations?

- ☐ Yes (please specify)
- ☐ No

A7. What restrictions in possible Land Uses/Developments apply within the relevant zones?

- ☐ Totally restricted use
- ☐ Zoning system dependent on generic use categories
- ☐ Zoning system dependent on societal risk
- ☐ Case-by-case
- ☐ Other (specify)

A8. What status do the criteria have?

- ☐ Boundary values included in the national or regional legislation that in no circumstances are allowed to be exceeded
- ☐ Boundary values included in the national or regional legislation that can be exceeded under exceptional circumstances (procedure for doing that is in place)
- ☐ Recommended target values (deviation is possible by local/regional authorities upon justification)
- ☐ Advised values (responsibility for following them stays entirely within the local/regional authorities)
- ☐ Other (please describe)

A9. What were the main considerations of giving the criteria this status?

A10. If national or regional criteria for distances are established, are the local authorities allowed to perform specific Risk Assessment that would alter the national or regional advice?

- ☐ Yes
- ☐ No

A11. Are there specific measures taken at a national level to reduce the uncertainty in the results of Risk Assessment (e.g. guidelines on tools, criteria, frequencies – standardisation – performance by accredited body – review by accredited body)?

- ☐ Yes
- ☐ No

A12. Are there specific measures addressing the impact on land use planning of new scientific knowledge on the criteria and methodology used?

- ☐ Yes
- ☐ No

A13. How is the technical advice on the risks arising from the establishment provided?*

* Please specify the type of body (governmental, private) and indicate the relationship to the authority responsible for LUP decisions

A14. What authority holds responsibility for the final decision?

A15. Which other authorities are involved? Is there a link to the IPPC-procedure in case of new sitings or substantial changes?**

**Please note that Article 12 of Seveso II also includes "other related policies" e.g. permit procedures of all kind of relevant instruments

A16. How is the assignment of responsibilities laid down to assure transparency and make the allocation of tasks evident to all involved bodies (e.g. national strategy plans, legal responsibilities etc.)?

A17. How is the public informed to assure the transparency of the decision-making process?

B. Implementation of Art.12 from Seveso II

B1. What procedure ensures that **modifications** of existing establishments are controlled in such a way that technical measures will be implemented in case the risks to people increase?

B2. What procedure ensures that **new developments in the vicinity** of an existing establishment are controlled?

B3. What procedure ensures that **siting of new establishments** is controlled in such a way that appropriate distances between new establishments and residential and other LUP-sensitive areas are maintained?

B4. What procedures are in place such that technical measures are taken so as not to increase the risk or consequences to people?

B5. What **consultation procedure** ensures that the public involved is informed and can influence the decisions to be taken?

C. Properties constituting "Good practice"

C1. Which properties do you believe that constitute 'good practice' in LUP?
(Give your grade between 1 and 5, 1=not important, 5=extremely important to each element)

- ☐ Transparency[1] 1 2 3 4 5
- ☐ Consistency[2] 1 2 3 4 5
- ☐ Simplicity[3] 1 2 3 4 5
- ☐ Proportionality[4] 1 2 3 4 5
- ☐ Robustness[5] 1 2 3 4 5
- ☐ Other (please describe and give your Grade)

C2. Which elements of your system contribute most in achieving these properties?

1 "Transparency" means that the methodology has to assure a clear understanding of the decision-making process
2 "Consistency" means that outcomes of the assessment of broadly similar situations are broadly the same under similar conditions
3 "Simplicity" means the avoidance of unnecessary complexity
4 [4]"Proportionality" refers to the balance of constraints with the level of risk
5 [5]"Robustness" is a super-structural term which includes other properties and expresses the probability how valid a decision will be over time

CHAPTER 5

Learning by comparison

As a source of exchange, innovation and creativity, cultural diversity is as necessary for humankind as biodiversity is for nature. In this sense, it is the common heritage of humanity and should be recognized and affirmed for the benefit of present and future generations

UNESCO Universal Declaration on Cultural Diversity, 2001

In this Chapter the various countries' methodologies for land use planning in areas subject to major accidents risk are compared. The comparison aims at exploring the legislative, methodological and cultural features which may explain the different national policies described in the previous Chapter. To do so, a case-study applying 4 of the 5 methodologies (namely the French, Dutch, British and Italian ones) in an industrial area in Piombino (Italy) is reported and discussed[405]. The case-study was performed before the emanation of the new French legislation and refers to the deterministic method until then in place. Considering the scope of the comparison, which was highlighting the differences among consequence-based vs. risk-based methods for land use planning in areas subject to major accidents risk, the application of the French method in force before 2003 appeared as the most appropriate.

A second comparison focuses on the elaboration and use of "risk maps" for supporting land use planning process and focuses on two countries, namely The United Kingdom and The Netherlands. Results of this comparison where presented in the context of the European project "ARMONIA: Multi-Risks and Mapping"[406] and further published in a journal article. The final proceedings of the ARMONIA project are used as a reference for addressing some general remarks over the orientations of the analyzed countries in terms of their focus on different variables and concepts for performing land use planning evaluations (i.e. resilience, vulnerability, etc.). A third comparison addresses some qualitative remarks about the cultural orientations of the analyzed Countries and their role for shaping the different methodologies.

In conclusion, the Chapter shows how the different methods developed in Europe mirror the legislative, methodological and ultimately cultural orientations of the selected Members of the Community. Nevertheless, common problematic aspects of land use planning in areas subject to major accidents risk are highlighted, such as the matter of integrating environmental vulnerability assessment within land use planning evaluations and dealing with the multi-dimensionality of the matter of risk, with particular regard of the evaluation, in the long-term, of the "tangible" and "intangible" consequences of accidents. From a disciplinary perspective, a general disconnection

[405] Cozzani *et al* (2006), *op. cit*.
[406] C. Basta (2007), *op. cit.*

between risk analysis and land use planning practices is observable, although with different degrees, in all analyzed Countries. Here, the recommendation of promoting guiding principles at European level for "importing" the evaluation of risks within ordinary planning practices by means of a common framework for what regard the definitions and integrations of the various elements to be considered for planning purposes is given.

These remarks will be further discussed in Chapter 6, wherein the "limits and horizons" of a joint European approach for land use planning in at-risk areas will be discussed.

5.1 Common and different aspects of major accidents risk prevention in land use planning: general remarks

The country profiles reported in Chapter 4 show a number of differences among the rationale of policies developed in Member States for the prevention of major accidents risks. The methodological differences (probabilistic vs. deterministic methods) will be extensively discussed in the following section and are here only generally introduced. Scope of the present section is addressing some general remarks over the "profile" of these countries with respect to the historical developments of such policies and their main distinctive aspects. The main research questions the Chapter will try to respond are: how to explain the differences characterizing European national policies and the methods developed for preventing the consequences of major accidents risk? Which are the factors influencing their different developments? Which are the common problematic aspects of these policies which may be reflected in the future European regulation, and which are those "structurally" related to the various national realities of the Union which cannot find a common translation in supra-national regulation?

A first general issue which may be questioned is whether a European regulation is desirable *tout court*. This issue was already discussed in the Introduction and a partial reply was already given. As already evidenced, a European regulation aimed at preventing the consequences of major accidents risk is certainly desirable, both from a political and economical perspectives; in the first case because it provides a series of provisions which are in line with other common objectives, such as regional cohesion and environmental protection, and from the second perspective because it encourages the promotion of a "European standard" for what concern the obligations to be fulfilled in order to install and operate dangerous establishments. Furthermore, accidents may be trans-frontier phenomena and a European regulation in the field encourages the exchange of information, experiences and *lessons learned* among the countries of the Union. This is indication stemming from the increasing consideration of the European Major Accident Report System (MARS) by the side of State Members (Kirchsteiger 1999) and the fruitful cooperation among national delegates active in working groups such as the EWGLUP.

A second issue confirming the desirability of Directives such as the Seveso is that, in some Countries, a systematic method for land use planning in at-risk areas has been relatively recently regulated by law and as a consequence of their emanation. In Italy for example a specific regulation addressing the matter of land use planning in areas subject to major accidents risk was issued following the emanation of the Seveso II Directive, implemented in 1999. In some others, systematic methods were in place since the '80's and '90's of the past century and were reviewed also thanks to the relevant developments of European law. Finally, several countries have designed or reviewed their policies also by means of the example provided by other national regulations, whose visibility was certainly encouraged by means of the activities and the exchanges of

information performed at European level[407]. New and candidate Member States could take particular advantage from the availability of these studies and exchange of information.

Keeping in mind the sometimes profound differences evidenced in the analyzed countries, retracing some common aspects in their policies and methods is surely possible. The first and most evident is the mono-dimensionality of the characterization of risk in all regulations implementing the Seveso II Directives, wherein *risk* is always characterized in terms of (chance of) fatality of humans. This aspect is a sort of "bottom line" of European legislations, and allowed the comparability of four of the five analyzed methodologies by means of the case-study reported in the following section. Even if in some legislations, such as the French and the Italian ones, a more comprehensive evaluation of the various interconnections between natural and technological risks together with the consideration of the risk for the environment are required before elaborating relevant planning instruments, the criterion used for characterizing risk remains, in general, the (chance of) death for humans.

Whilst this criterion is enforced in all legislations, the consideration of the probabilities of events as mitigating factor for the evaluation of separation distances between hazards and surrounding environment is still the water-shed between the two main European methodological orientations, namely the risk-based and the consequence-based approaches (Christou 2000, Cozzani *et al* 2006). The rationale of the two methods is profoundly different: whereas in the first case the probabilities of events may be accounted as a mitigating factor for the assessment of opportune safety distances between hazards and surrounding population and environment, in the second only their consequences are considered[408]. It may be said that, the first case, legislations set a level of *risk* acceptability while, in the second case, they set a level of *consequences* acceptability, the latter usually assessed considering *worst-case* scenarios. It is important to notice that such levels are not necessarily legally binding and that fixed or target criteria apply in different legislative contexts. However, it can generally accepted that consequence-based methods are more conservative than risk-oriented methods (Christou 2000, Cozzani *et al* 2006) and that, from a policy perspective, they seem to respond to a more precautionary approach.

A second remark is the lack of provision, in most of regulations, of specific criteria for the assessment of the risk to the environment. Beside Italy, whose adopted criterion demonstrated to be of rather difficult application, in the other analyzed national legislations implementing Art 12 there are no specific criteria in place for assessing the compatibility of the environment with respect to the consequences of major accidents. This is an important "weak point" of legislations as it reflects a difficulty which is, primarily, disciplinary: as discussed before, an agreed definition and assessment of environmental vulnerability with regard to the risk of major accidents is not established in literature, and the regulations "covering" this problematic aspect of the siting and operation of dangerous facilities (like the EIA and the IPCC Directives) are partially inefficient with regard to the "extraordinary impacts" on the environment represented by accidents. One of the consequences of this aspect is that, generally, the risk to people and the risk to the environment are somehow treated separately during the elaboration of planning instruments. Furthermore, relevant evaluations are usually performed by different Authorities.

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[407] Refer to the comparative studies performed in the United Kingdom (1996) and The Netherlands (2004) mentioned in the previous Chapter.

[408] However, also consequence-based methods may involve an implicit probabilistic consideration during the selection of reference scenarios. In Germany for example, which is the only country in which there is still a strong deterministic orientation, under certain conditions the "most credible" scenario may be used as reference for land use planning purposes in place of the "worst scenario". Here, a probabilistic judgment over the "credibility" of scenarios comes into play. This will be discussed in the final Conclusions.

The role of safety authorities in the elaboration of land use plans appears central in all analyzed countries. From the centrality of role of the Health and Safety Executive in the United Kingdom to the *ad hoc* appointment of specific Technical Committees in Italy, land use planning evaluations are invariably derived from the advice of safety authorities, which are primarily based on the information provided by Operators[409]. Safety Reports are a primary informative source for the development of the whole procedure, from the licensing of establishments, the evaluation of their compatibility with the surrounding environment up to the elaboration of internal and external emergency planning instruments. The liability of Operators in regard is a principle strongly enforced in the majority of Countries.

From the point of view of the "status" of the information contained within Safety Reports, it is important to notice that they are not necessarily a public document, and that restrictions to their consultation by the side of the public may apply. Generally, only a limited version of Safety Reports specifically aimed at informing the public about the risk of major accidents is available. Relevant information, such as the identification of the iso-risk or iso-effects contours, may be also object of a different level of publicity.

In general, planning instruments become also the instruments by means of which this kind of information becomes available to the public. Nevertheless, the access to detailed geographically based information (so-called "risk maps") is differently developed in the various countries. The Netherlands and France have established on-line informative platforms wherein integrated provincial risk-maps are directly accessible by the side of the public; notably on a theoretical global scale. In the United Kingdom, the risk-maps elaborated by HSE to establish consultation zones and supporting planning evaluations are instead accessible only by means of specific request and are hence not considered as a public document. In Italy, the Ministry of Environment publishes the inventory of "Seveso sites" on its website and updates relevant data every six months. Nevertheless, the information related to the risk-contours is only reported within the Technical Paper on Major Accidents Risk, "reaching" the public once the relevant planning instrument is published for being submitted to public consultation.

Although a detailed analysis of the different "information policies" developed in the analyzed Countries will be here limited to two of them (The Netherlands and The United Kingdom)[410], their differences offer a point of reflection for what regard the possible developments of similar systems in the Union.

A final general remark is that the majority of European countries developed their risk MA prevention policies following a number of significant accidents, after which more or less restrictive and integrated policies were issued and enforced. The accident in Flixborough in the United Kingdom and, more recently, the accidents in Enschede in The Netherlands and in Toulouse in France have had a clear and sometimes explicit influence on national MA risk prevention policy

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[409] Though this remark is generally valid, it has to be pointed out that the autonomy of planning authorities with respect to safety ones in the elaboration of planning instruments with regard to dangerous establishments has different degrees in Europe. Here, the United Kingdom offers an other example of quite advanced practice: the creation of the software PADHI+, described in the relevant country profile, was aimed at enhancing the autonomy of Local Planning Agencies with respect to HSE offices. Theoretically, Local Planning Agencies may perform their land use planning evaluations by means of the utilization of the software and the relevant guidance without further consulting HSE, at least in those cases in which the outcomes of evaluations are not controversial and in need of further investigation. From a disciplinary perspective this aspect of the United Kingdom practice is of sure interest, as it encourages the acquisition of competences by the side of planners with regard to the matter of MA risk prevention and a better integration, within planning processes, of the "matter of risk" as an ordinary "planning matter".

[410] C. Basta *et al* (2006), *op. cit*.

developments. As extensively argued in the course of this book, European safety regulations are essentially the results of a series of lessons learned from accidents.

Though these accidents have been a sure triggering factor for the development of relevant regulations, related *lessons learned* would be not sufficient for deriving, in a sort of cause-consequence manner, relevant national legislative and methodological orientations. Before the accidents of Seveso, similar (though minor) events involving the release of dioxins were reported in France and United Kingdom, whose policies and legislations are rather different than those of the Mediterranean peninsula[411]. National "accidents histories" are therefore not sufficient to derive the different policy developments of European nations. Other factors should be accounted. Among them, four general factors may be individualized, namely

1. the (national, regional)) legislative background;
2. the (national, regional) demographic and geographical contexts;
3. the (national, regional) economical relevance of the chemical industry;
4. the (national, regional) cultural orientation.

The first factor emerges from the comparison of the United Kingdom legislation with respect to the one in place in the rest of Europe. In the Kingdom, the liability of Operators is a primary focus of legislation; the centrality of the principle of ALARP both to the management of establishments by the side of Operators and the definition and implementation of prevention measures by the side of Authorities is a clear example of the strong focus on the liability of actors in the risk prevention system. The absence of the typically continental legally-binding risk acceptability thresholds and, implicitly, the existence of a judgmental approach based on a case-by-case evaluation of every single situation, recalls the tradition of a legal system based on the resolution of controversies without referring to a pre-existing legal code. A second example of a regulation strongly affected by the legislative background of the Country is represented by Germany, where the federal constitutional principles (in particular, the precautionary principle) cannot be overruled by national and regional legislations. In this context, the adoption of a deterministic method for the assessment of land use planning measures that does not consider the probabilities of events appears as the only consistent approach.

The different demographical and geographical situations of European countries are also factors influencing the adoption of related risk prevention policies. In The Netherlands, the scarcity of land and the high population density would represent a limit for the adoption of deterministic methods based on the consideration of worst scenarios: the costs associated to large protection zones would be higher than in less densely populated or more territorially extended countries. Thus a strict regulation aimed at decreasing risks at source and a strong integration of the matter of risk prevention within planning instruments appears consistent with this particular geographical and demographical context. In consideration of the necessity of maintaining the economical standards together with a livable environment, environmental and spatial planning policies assume the role of general framework for all safety-related matters: in the country, the Environmental Protection Act is the primary regulatory framework from which both spatial planning and risk prevention policies decay. In this regard, spatial planning policies are a sort of *longa manu* by means of which safety related matters with regard to both natural and technological risks are regulated.

The economical relevance of the chemical industry in the various countries is also a factor which may influence risk prevention policy developments. In general, Europe is the second largest producer and seller of chemical products (CEFIC 2008)[412]. In Fig 17, the geographical breakdown of European sales is reported:

[411] F. Lees (1996), *op. cit.*

[412] Refer to the website of the European Chemical Federation, www.cefic.be. Last visited: April 2008

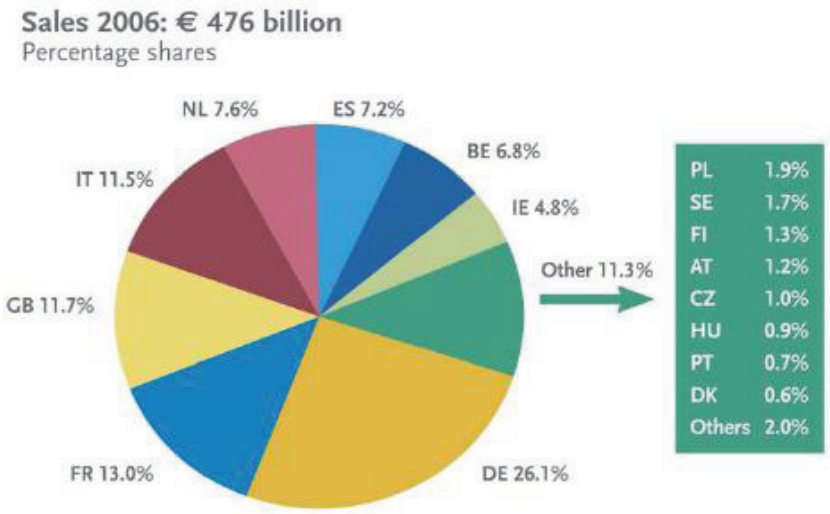

Fig 17 – geographical breakdown of the chemical industry in European Countries (retrieved from CEFIC 2008)

According to the figure, Germany is the largest chemicals producer in Europe, followed by France, Italy and the UK. The Netherlands follows with a minor share, mirroring the limited dimension of the Country more than the minor relevance of the sector, still higher than in the rest of European countries. As illustrated in Fig 18 the chemical sector is vital to a number of other productive sectors, many of them, again, of fundamental relevance to national industries (like the steel industry in Germany) [FIG 18]:

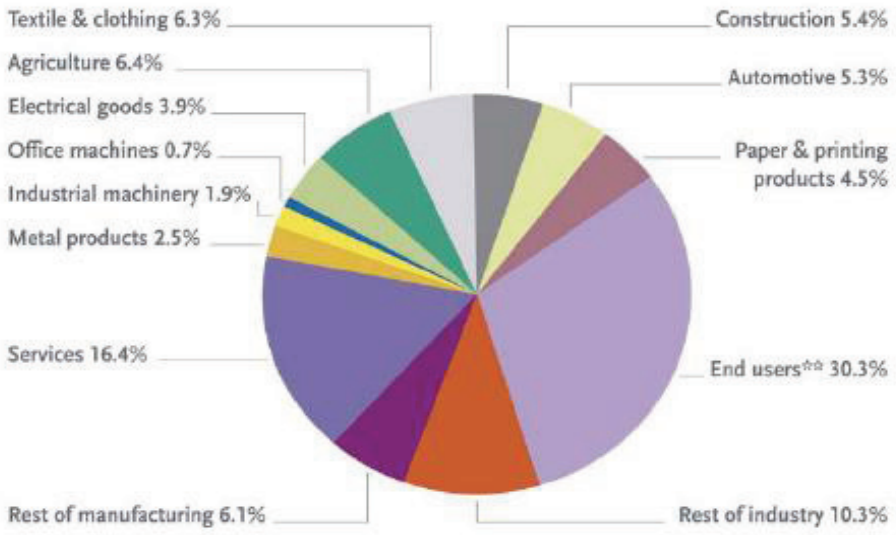

Fig 18 – European chemical industry consumption structure (retrieved from CEFIC 2008)

Germany, United Kingdom, France, The Netherlands and Italy constitute the rose of countries leading the European chemical industry. The fact they are also those mostly reported in literature with regard to their MA risk prevention policies and are somehow regarded as a reference for the rest of Europe, is obviously not a coincidence. The major presence of establishments in these countries and the necessity, on the one hand, to maintain associated economical benefits and, on the other hand, to guarantee relevant safety standards has surely been an incentive for regulators for elaborating more sophisticated and comprehensive risk prevention policies.

This elaboration is, however, also influenced by different cultural orientations. Though of more complex investigation, the "cultural basis" of risk regulations may explain many aspects of the different policies developed in Europe. This interesting and relatively unexplored aspect of European MA risk regulations, will be extensively discussed in section 5.5. In the following section I will focus on the methodological differences associated to the different described regulations by means of a case-study, in which four of the five described national regulations are applied to the same industrial area.

5.2 Comparing 4 national land use planning methods adopting a GIS technology. Is there a method "safer" than others?

This section replicates a previously published case-study on the application of the land use planning methods developed in 4 of the 5 analyzed countries to an industrial area[413]. The case-study was performed before the emanation of the new French legislation of 2003, when the various aspects of the new approach (such as the compatibility matrix and the threshold values to be used to perform planning evaluations) where not specifically defined yet. This is the reason why the case-study referred to the method in use in France before the emanation of the new law. Considering the scope of the comparison, which is highlighting the differences between probabilistic, deterministic and semi-quantitative approaches to land use planning in the context of major accidents risk, the application of the original deterministic French approach appeared consistent with the scope of the analysis.

In order to perform the comparative analysis, an Italian industrial area has been selected. The different LUP criteria have been used both to evaluate the present state of the area and the effect of several proposed hazard reduction actions. The results obtained have allowed a comparison of the different LUP methodologies. Critical steps in the application of the different LUP criteria have been identified, and the different priorities of hazard reduction actions have been highlighted. Results of the study shown that three approaches to land use planning in areas subject to major accidents risk can be classified:

1) The consequence-based approach, focusing the assessment of the consequences of a number of conceivable scenarios (reference scenarios). Damage thresholds values for accident physical effects (toxic concentration, thermal radiation, overpressure) are determined with respect to undesired consequences (fatalities, irreversible effects, reversible effects, etc.). The method was used in France prior to the new law of 2003 and is still used in Germany;

2) The risk-based approach, focusing on the assessment of both consequences and expected occurrence frequency of possible accident scenarios. The results are represented by risk indexes, in

[413] Cozzani *et al* (2006), *op. cit*. I want to specify that the parts of the article which have seen my contribution are part of the Introduction, wherein the several methods and the relevant legislative references are given together with the classification of the different methodological orientations (consequence-based vs. risk-based), the sections concerning the several land use planning criteria per each country, the final comparison of results and part of the conclusions. The QARA study of the area of Piombino was "borrowed" from a previous publication which was not performed by the Authors.

some cases both as individual risk and societal risk. Land use planning criteria are based on specific acceptability criteria with respect to the calculated risk indexes. This approach is applied in the United Kingdom and in The Netherlands;
3) Semi-quantitative approach, adopted in Italy in 2001, which takes into account frequencies as a mitigation factor for the damage zones, identified using a consequence-oriented approach. Although the Italian legislation was somehow inspired by the English and Dutch regulations, it does not require the evaluation of the societal risk.

The aim of the case-study was comparing the results of the application of the different criteria to an existing industrial area. The final objective was identifying the land-use restrictions imposed by the different criteria and to underline which types of hazard reduction actions may be prioritized according to the different approaches. An Italian industrial area, an industrial zone of Piombino, has been chosen for the study. In this area a quantitative area risk assessment (QARA) study was performed in 1998. Complete information were therefore available both with regard to hazardous installations and the transport of hazardous goods. On the basis of the results of the QARA study, the local authorities proposed several hazard reduction actions. The different LUP criteria are applied both to the present situation and to the situation after the hazard reduction actions. The map of the area considered for the case-study is reported in Fig 19:

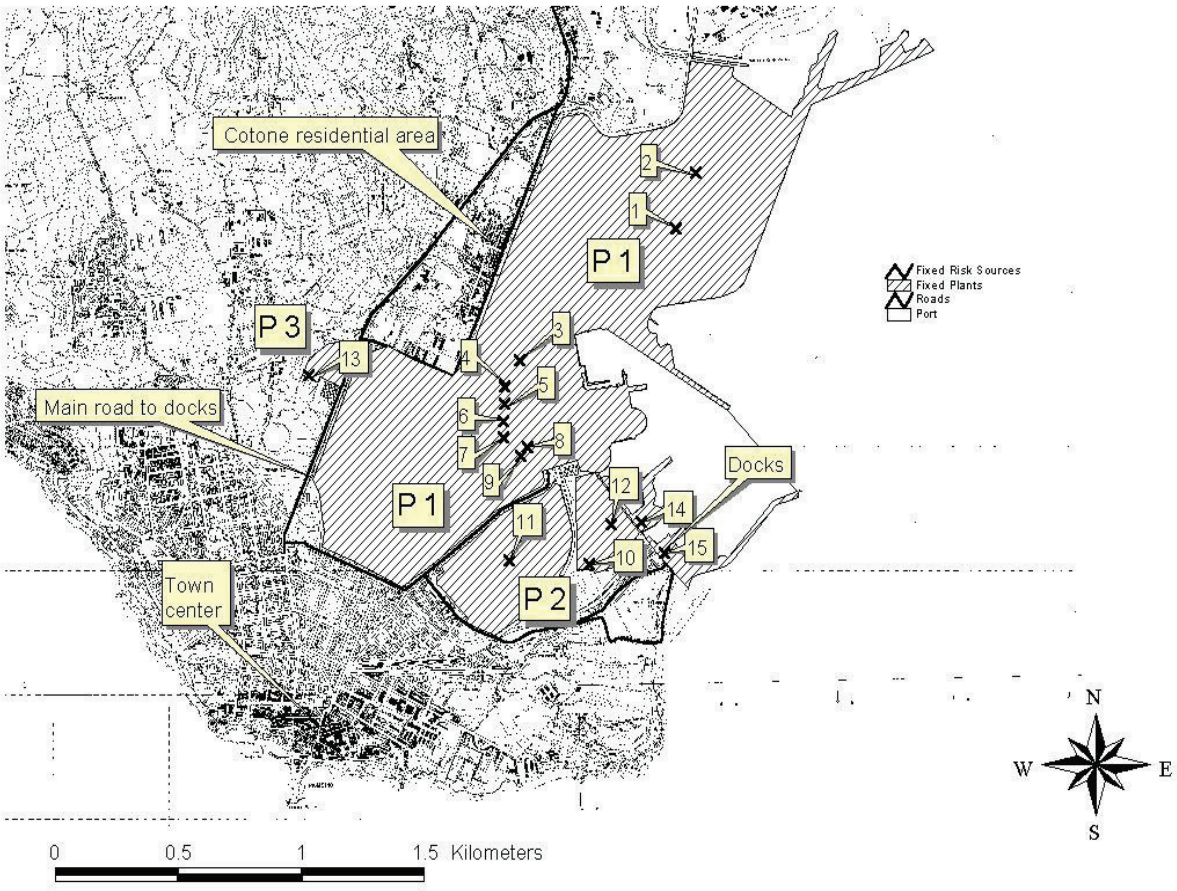

Fig 19 – The industrial area of Piombino and the individualized risk sources (from Cozzani *et al* 2006)

The Piombino area it is an Italian area with 3 industrial plants falling under the obligations of the Seveso II Directive. Two of these plants (P1 and P2) are establishments producing and processing steel, while the other (P3) is an air distillation plant. It is important to remark the proximity between the industrial areas and some residential districts of the town (especially the zone of Cotone), as shown in Fig. 19.

The port of Piombino also represents a very important risk source in the area. The port manages a relevant touristy traffic, consisting of more than 3500000 passengers/year. Furthermore, the port also manages a significant commercial traffic. The commercial traffic leads to the presence of a relevant number of trucks loaded with hazardous substances (in particular explosives, LPG and gasoline). Both the touristy and commercial traffic consist of vehicles loaded or unloaded from ferry boats. No storages are present in the port. Only 7 buried diesel fuel deposits are present for ferry-boat re-fuelling. The docks and the loading/unloading areas are very small and in the present situation no physical buffer is present between the touristy and commercial areas of the port.

With respect to the transport of hazardous goods, there is only one main road in the area, which is the road connecting Piombino to the main highway from which the northern or southern main transportation routes of Italy are accessible. Thus all the traffic directed to Piombino transits on this road. Moreover, the final part of this route runs inside the town centre and is often crowded with local traffic, creating a congestion that may increase the impacts of potentially dangerous situations.

In order to apply and compare the different European LUP criteria, detailed information on the risk sources present in the area were collected. The Italian Ministry of Environment together with the Toscana Regional Authorities promoted in 1998 a QARA study of the Livorno and Piombino areas. The Piombino QARA study was coordinated by ARPAT (the Regional Environmental Protection Agency) and performed by the University of Pisa. Both the fixed risk sources and the hazards due to the transport of hazardous substances in the area were considered[414]. Thus a detailed analysis of the risk sources present in the Piombino area was available.

In order to perform the present study, the 1998 QARA study has been updated taking into account the modifications occurred to the fixed plants present in the area. The study has been upgraded using the 2.1 version of the Aripar-GIS software[415]. Figure 19 shows the position of the fixed risk sources, and Table 18 reports the accidental scenarios considered in the updated QARA study. Furthermore Table 19 summarizes the data on the transport of hazardous substances in the area:

[414] Results of the QARA study are reported elsewhere. Refer to M. Mossa Verre (eds.), *Analisi del rischio per l'area di Piombino e strategie di intervento*, ARPAT, Florence (I), 2000; see also V. Cozzani *et al*, "The use of Quantitative Area Risk Assessment techniques in land-use planning", in G.A. Papadakis (eds.), *Risk management in the European Union of 2000, EUR 19664 EN, Commission of the European Communities*, 2001, pp.411. Considering the scope of this Chapter, which is reflecting on the different outcomes deriving from the applications of different criteria and methods to land use planning evaluations, a detailed account of the QARA study is not reported.

[415] For a detailed description of the GIS software refer to F. Bellezza *et al*, "A GIS based software tool for risk assessment and management in industrial areas", in: S. Lydersen, G.K. Hansen and H.A. Sandtorv (eds.), Safety and Reliability, Vol. 1, 1998, p.67. Reported by Cozzani et al (2006), *op. cit.*

Table 18 – data of risk fixed sources and scenarios considered in the QARA study (from Cozzani *et al* 2006)

Source n.	Substance	Scenario	Freq. (ev/year)	*French Method*		*Italian Method*				
				Z1 *(m)*	***Z2*** *(m)*	**freq. class**	***R1*** *(m)*	***R2*** *(m)*	***R3*** *(m)*	***R4*** *(m)*
1	Blast Furn.Gas	UVCE	$3.20 \cdot 10^{-3}$	115	250	1	35	75	150	350
2	Coke Gas	UVCE	-	370	805	-	-	-	-	-
	Coke Gas	Jet Fire	$2.04 \cdot 10^{-4}$	-	-	2	21	28	33	42
	Coke Gas	UVCE	$1.10 \cdot 10^{-4}$	-	-	2	45	97	193	450
3	Blast Furn.Gas	UVCE	-	350	760	-	-	-	-	-
	Blast Furn.Gas	Jet Fire	$2.04 \cdot 10^{-4}$	-	-	2	21	28	33	42
	Blast Furn.Gas	UVCE	$1.10 \cdot 10^{-4}$	-	-	2	45	97	193	450
4	Coke Gas	UVCE	$5.00 \cdot 10^{-5}$	65	145	3	30	45	90	300
5	Coke Gas	UVCE	$5.00 \cdot 10^{-5}$	65	145	3	30	45	90	300
6	Coke Gas	UVCE	$5.00 \cdot 10^{-5}$	65	145	3	30	45	90	300
7	Coke Gas	UVCE	$5.00 \cdot 10^{-5}$	65	145	3	30	45	90	300
8	Blast Furn.Gas	UVCE	-	295	640	-	-	-	-	-
	Blast Furn.Gas	Jet Fire	$2.04 \cdot 10^{-4}$	-	-	2	21	28	33	42
	Blast Furn.Gas	UVCE	$1.10 \cdot 10^{-4}$	-	-	2	45	97	193	450
9	Coke Gas	UVCE	$3.20 \cdot 10^{-3}$	130	285	1	35	75	150	350
10	Ammonia	Inst. Release	-	1165	2140	-	-	-	-	-
11	Ammonia	Cont. Release	$3.03 \cdot 10^{-5}$	-	-	3	0	-	300	-
	Ammonia	Cont. Release	$1.00 \cdot 10^{-8}$	60	450	4	0	-	550	-
12	Ammonia	Cont. Release	$9.47 \cdot 10^{-7}$	-	-	4	0	-	25	-
13	Paints	Pool Fire	$4.60 \cdot 10^{-4}$	45	55	2	23	37	45	67
	HCl	Cont. Release	$4.60 \cdot 10^{-4}$	-	-	2	0	-	40	-
	HF	Cont. Release	$4.60 \cdot 10^{-4}$	-	-	2	0	-	75	-
14	Diesel fuel	Pool Fire	$4.00 \cdot 10^{-9}$	60	75	4	23	37	45	67
15	Diesel fuel	Pool Fire	$2.00 \cdot 10^{-6}$	60	75	3	25	28	34	45
	LPG	UVCE	$1.00 \cdot 10^{-6}$	275	600	4	10	25	45	75
	LPG	Jet Fire	$1.50 \cdot 10^{-6}$	-	-	3	105	118	130	152
	Explosives	UVCE	$5.00 \cdot 10^{-7}$	250	685	4	57	122	244	569

Table 19 – estimation of road transport of dangerous substances in the Case-study area (from Cozzani *et al* 2006)

Substance	Quantity	
	(trucks/y)	(t/y)
LPG	748	14960
Gasoline	82	1596
Diesel fuel	2500	64097
Flammable liquids	45	900
Organic solvents	20	275
Paints	320	5760
Explosives	301	8
Calcium Carbide	180	4500
Hydrochloric acid	120	2550
Ammonia	30	420
Liquid Oxygen	2669	58718
Liquid Nitrogen	1725	37950
Liquid Argon	345	7590
Total	**9085**	**199324**

Figure 20 shows the map of the individual risk in the area, obtained using the Aripar-GIS Software:

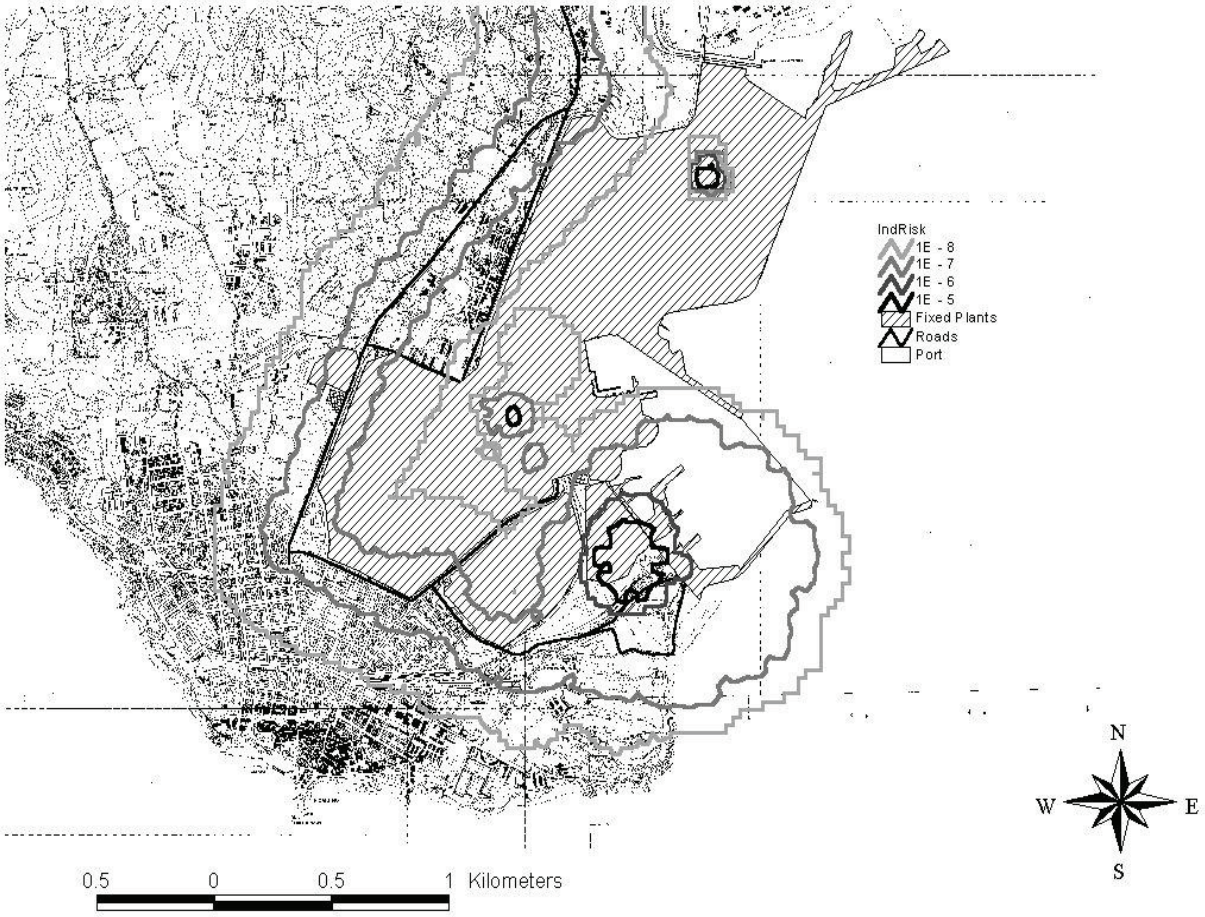

Fig 20 – Individual risk in the area calculated with the Aripar-GIS software (from Cozzani *et al* 2006)

It is important to notice that the docks where the trucks are loaded on ferry boats are considered as fixed installations. However, the most important risk sources identified in the area are the docks and the process plants near to the port, also due to the high number of tourists that are exposed to the hazards. Figure 20 shows that with the used methodology the individual risk in the residential areas results generally lower than 10^{-7} events/year. Values higher than 10^{-5} events/year are present in the proximity of the industrial plants, and in a small zone between the P2 plant and the harbor area. The most important contribution to the individual risk in the residential areas is given by the road transport of hazardous substances, especially on the route directed to the industrial plants and to the port, with values comprised between 10^{-7} and 10^{-8} events/year.

The societal risk in the area is represented in Figure 21, reporting the calculated FN curve for >10, >100, >1000 and >10000 N. The societal risk shows frequency values (F) of about 10^{-5} events/year for N less than 100. The values of F become quite negligible for N higher than 1000:

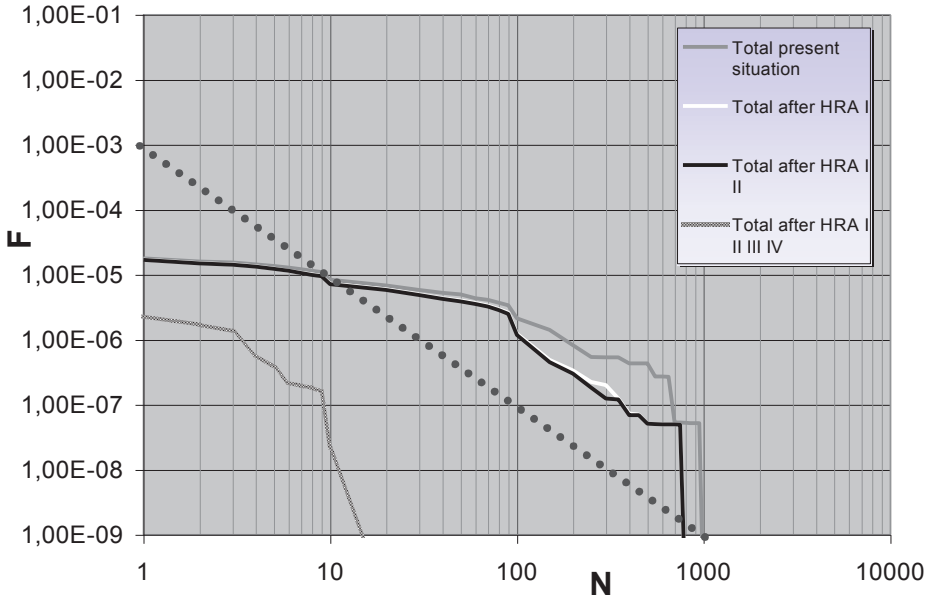

Fig 21 – calculated FN curves in the area of the case-study (from Cozzani *et al* 2006)

5.2.1 Application of the French land use planning criteria[416]

The French LUP criterion and the procedures to be followed for its application before the entry into force of the new law of 2003 are fully described in Chapter 4. All the fixed risk sources shown in Fig 19 were considered for the application of the French method. It must be underlined that the then French approach did not take into account the hazards deriving from the transportation of dangerous substances in LUP. However, the risk hazards caused by the loading and unloading of hazardous materials on the ferry boats in the port docks were considered as fixed risk sources in the QARA study, and were thus considered in the analysis.

The application of the French approach required the identification of the worst-case scenario for each risk source and the calculation of the damage zones. The worst-case scenarios were identified "a priori" or through the comparison of all the alternative accidental scenarios, selecting the one which generated the widest damage zones. The threshold values used to calculate the protection zones were extrapolated from official documents produced by the SEI (Service de l'Environnement Industriel)[417]. Through the application of the French LUP method, circular protection zones (Z1 and Z2) are identified, having the risk source in their centre. In order to calculate the damage zones of the different scenarios, the recommended simplifying equations commonly used for this purpose in France and reported in literature were used[418]. The protection zones due to toxic releases were calculated using the SAFETI software, which allows to model both the release and the atmospheric dispersion. Table 18 reports all the fixed risk sources

[416] It's worth repeating that the French method applied in the case-study refers to the legislation in place before 2003.

[417] Refer to Ministere de l'Amenagement du territorie et de l'Environnement, Service de l'Environnement Industriel, *Courbes de Toxicite aiguë par inhalation*, Paris, 1998. Reported by Cozzani et al (2006), *op. cit*.

[418] Refer to Secretary of State to the French Minister for the Environment and the Prevention of Major Technological and Natural, *Control of urban development around high risk industrial sites*, Paris, 1990. Reported by Cozzani et al (2006), *op. cit*.

considered, the worst case scenarios and the related extensions of damage zones. The calculated radii of these zones are represented by the Z1 and Z2 damage distances also reported in the table. Figure 22 reports the position of the Z1 zones in the Piombino area:

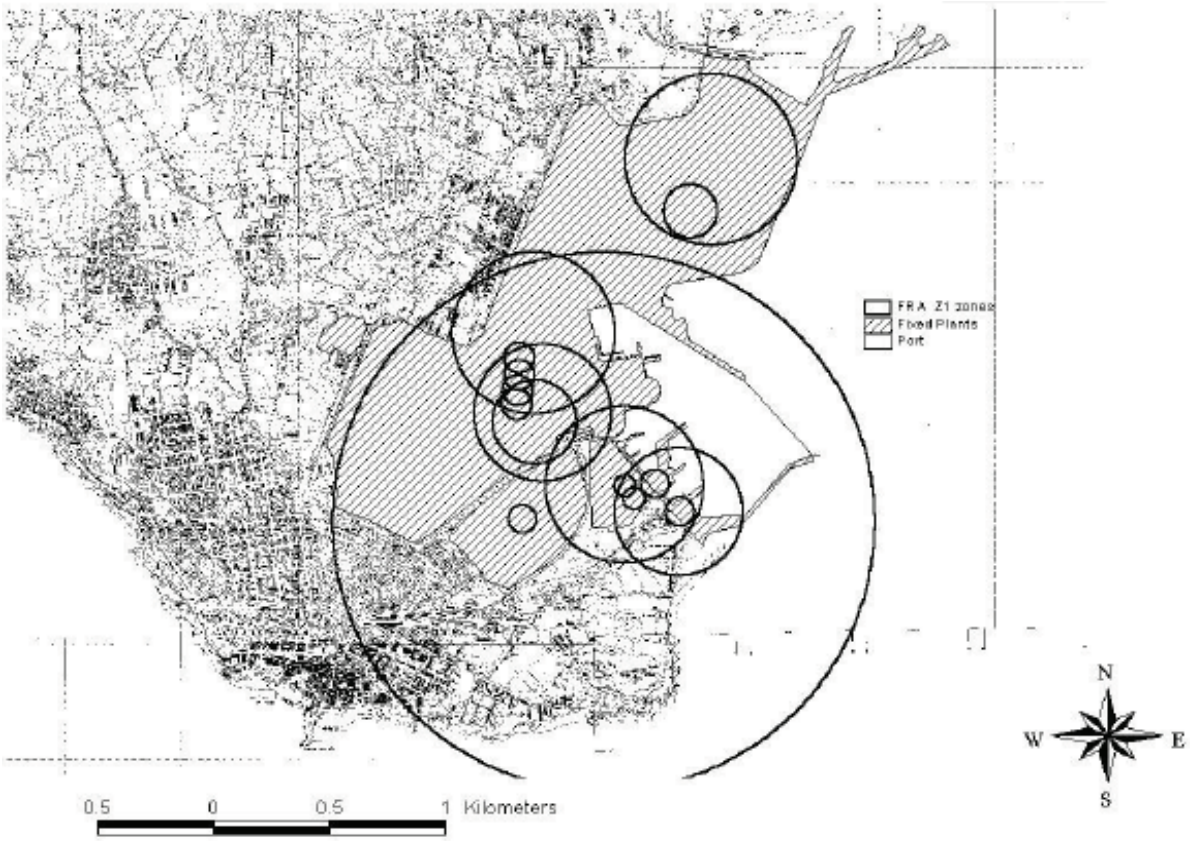

Fig 22 – Application of the French LUP criteria (from Cozzani *et al* 2006)

As shown in the Figure, the toxic releases are the accidental scenarios that generate the most extended damage areas. In particular, the release of pressurized liquid ammonia from a tank storage located inside the P2 plant (risk source n.10 in tab.1) creates the biggest Z1 zone in the Piombino area, that extends over several residential areas of the town. The other wide Z1 zones are generated by the UVCE scenarios caused by the possible catastrophic release of flammable gases from the atmospheric gasholders inside the P1 plant. The damage area caused by a gasholder (risk source n.3 in fig.1) partially extends over the residential area of Cotone.

The Z2 zone caused by the toxic release of ammonia extends over the entire town centre. The other Z2 areas, mainly generated by catastrophic releases from the gasholders, cover the residential area of Cotone entirely. The Z2 zones caused by the scenarios due to loading/unloading operations and to fuel storages in the port are extended over the entire harbor area. Thus, the application of the French lead to the identification of wide protection zones, including several residential areas. A strong indication comes for the need of hazard reduction actions, limiting the quantities of the dangerous substances causing the scenarios, or removing the risk sources.

5.2.2 Application of the Dutch land use planning criteria

The application of the Dutch criterion required the calculation of individual and societal risk. To correctly apply the Dutch LUP method, the approach to scenario selection and to risk calculation given by the "purple book" should be used[419]. In particular, the purple book reports a set of mandatory accidental scenarios associated to a set of frequency values, but states that site-specific values, when available, should be preferred to standard values. Since within the QARA study of the Piombino area an extended revision of the possible accidental scenarios and of their frequency values was carried out, the individual and societal risk calculated within the QARA study by the Aripar-GIS software were directly compared with the acceptability criteria used in the Netherlands.

As reported in Chapter 3 the Dutch threshold value for individual risk acceptability in residential areas is 10^{-6} events/year. Fig 20 shows that the individual risk is higher than 10^{-6} events/year only in a narrow area that extends also outside the industrial sites. An area where individual risk is higher than 10^{-5} events/year is present in the proximity of the industrial plants, where only some storehouses and the Port Authority offices are located. In the 10^{-6} area the touristy ferry-boat docks, a railway station and some road networks to the harbor area are present. This causes the societal risk curve, reported in Fig 21, to be well above the acceptable values, due to the quite high expected frequency of possible severe accidents involving the harbor area.

In conclusion, with respect to individual risk the situation is under control in all the residential areas of the town. On the other hand, the societal risk exceeds the acceptability criteria used in the Netherlands for land use planning issues, as shown in Fig 21, where the pointed line represents the acceptability level. Thus, the situation is not acceptable according to the Dutch criteria for land use planning, and the introduction of risk mitigation actions is required, mainly aimed to the reduction of the societal risk

5.2.3 Application of the British land use planning criteria

As extensively described the UK approach is based on individual risk calculation, but the effects of the road transport of dangerous substances are not considered in the standard methodology. Nevertheless the risk sources due to the loading/unloading procedures in the harbor areas were considered as fixed risk sources and included in the analysis. A standardized approach is performed by HSE when applying the LUP criterion. However, also in this case the site-specific QARA results were directly compared to the acceptability criteria given in the method. Thus, the Aripar-GIS software was used to calculate individual risk due to the fixed risk sources.

The results, reported in Fig 23, allowed the identification of the three consultation zones defined by the method: the inner zone (individual risk values higher than 10^{-5} events/year), the intermediate zone (individual risk values higher than 10^{-6} events/year), and the outer zone (individual risk values higher than 3.10^{-7} events/year):

[419] P.A.M. Uijt de Haag and B.J.M. Ale, *Guidelines for quantitative risk assessment (Purple Book)*, Committee for the Prevention of Disasters (eds), The Hague, 1999. Reported by Cozzani et all (2006), *op. cit*.

Fig 23 – Application of the British LUP criteria (from Cozzani *et al* 2006)

The inner zone is in the proximity of the industrial plants, between the P2 plant and the harbor area. The middle zone quite well corresponds to that identified by the Dutch method, and extends over the touristy ferry-boat docks and a railway station. The outer zone comprises the entire harbor area and two small residential areas. Within the inner zone, neither development or land uses in contrast with the HSE development advice policy can be found. The situation is different for the middle and the outer zone. The port docks (about 1000 passengers/day) are in the middle zone, and at the borders of the outer zone a hospital for elderly is present. According to the British criterion these kind of "targets" are not compatible with the risk, and hazard reduction actions are suggested.

5.2.4 Application of the Italian land use planning criteria

As described in Chapter 3, the Italian method is based on the identification, for each scenario considered, of four effect distances (lethality to material damages, R1 to R4) on the basis of damage thresholds for physical effects. A probability class (from 1 to 4) is associated to each scenario on the basis of its expected frequency. The probability class combined with the category of the damage area identifies the compatible land use destinations according to six vulnerability classes (A, highest vulnerability, to F, clear areas). Such classes are derived by means of a series of general indicators (like height and functional destination of buildings) and more specific indicators

for particularly sensitive objects (such as number of beds per hospital, daily traffic on railway stations, etc).

Accidental scenarios used for planning purposes are derived from the Seveso II safety reports. Thus, the accidental scenarios analyzed in the QARA study were the starting point for the application of the method. The first step was the evaluation of the four different damage areas and the classification of the frequency value of each scenario within one of the four probabilities classes prescribed by the Italian legislation. Results are summarized in Table 18. Fig 24 shows the damage areas, within which the vulnerability of land use destinations are identified. The effect areas falling entirely inside the areas of the establishments are not reported in the map:

Fig 24 – application of the Italian LUP criteria (from Cozzani *et al* 2006)

The second step of the application of the Italian method required the assessment of the vulnerability classes. All the residential and industrial areas comprised within the iso-damage areas were analyzed according to the Italian indicators. Fig 24 shows that the land use destinations of two areas resulted not compatible with the allowed development classes. The first is the area of Cotone. Here the highest allowable vulnerable category is category C, while the existing vulnerability corresponds to category B. The second area is represented by the port. As specified above, in this area there is a transit of more than 3.5 million persons per year, that corresponds to about 1000 average transits per day. Installations with more than 100 passengers/day correspond to the

vulnerability category B, while the allowed category here is E. Therefore, the land use destinations in these two zones are not acceptable according to the Italian land use planning criteria, and risk reduction measures are required.

5.2.5 Evaluation of hazards reduction measures

From the application of the LUP methods to the Piombino area, some conclusions may be drawn about the mitigation actions that should be considered, with the only exclusion of the zone of the touristy docks. The risk-based methods indicate that the individual risk is compatible with the present land use of the area. However, the societal risk is considerable, mainly due to the situation of the port. The Dutch criterion clearly indicates the need for a reduction of the societal risk, that may be achieved by strategies as:

1) actions on risk sources, as technical measures to reduce the frequencies of the possible accidents, or the expected consequences; or

2) actions on population, as moving the vulnerable targets away from hazardous areas.

On the other hand, the consequence-based criteria show that the consequences of the catastrophic toxic releases are not tolerable. Thus a clear indication comes from these methods for the reduction of the consequences associated to the scenarios related to the pressurized ammonia storage or its elimination. The hazard reduction actions proposed by the local authorities were examined in this perspectives. Four different hazard reduction actions were proposed:

1. The construction of a "buffer" parking zone for the touristy vehicles waiting to be loaded on ferry-boats;
2. The construction of a separated dock for the commercial traffic in a new harbor area;
3. The construction of a new road to access the port and the industrial area;
4. The elimination of the pressurized ammonia storage (risk source n.10 in Fig. 20)

Action 1 was proposed by the Port Authorities, in order to clear the area of the docks from vehicles waiting for the loading procedures. This action could both increase the safety of the loading and unloading operations and reduce the number of people exposed to the hazards arising from the hazardous substances in the area. Action 2 was included within the port development plan. New loading yards and docks should be realized in the northern side of the harbor area, and will be dedicated to the industrial and commercial traffic. This should generate a physical buffer between the tourists and commercial traffic, moving the risk sources represented by the loading/unloading operations of hazardous substances away from the areas dedicated to the tourists traffic. The new route to access the Piombino port and industrial area (action 3) should be dedicated exclusively to commercial traffic, thus avoiding that vehicles carrying hazardous substances may pass through the residential areas of the town. The new route is shown in Fig 25:

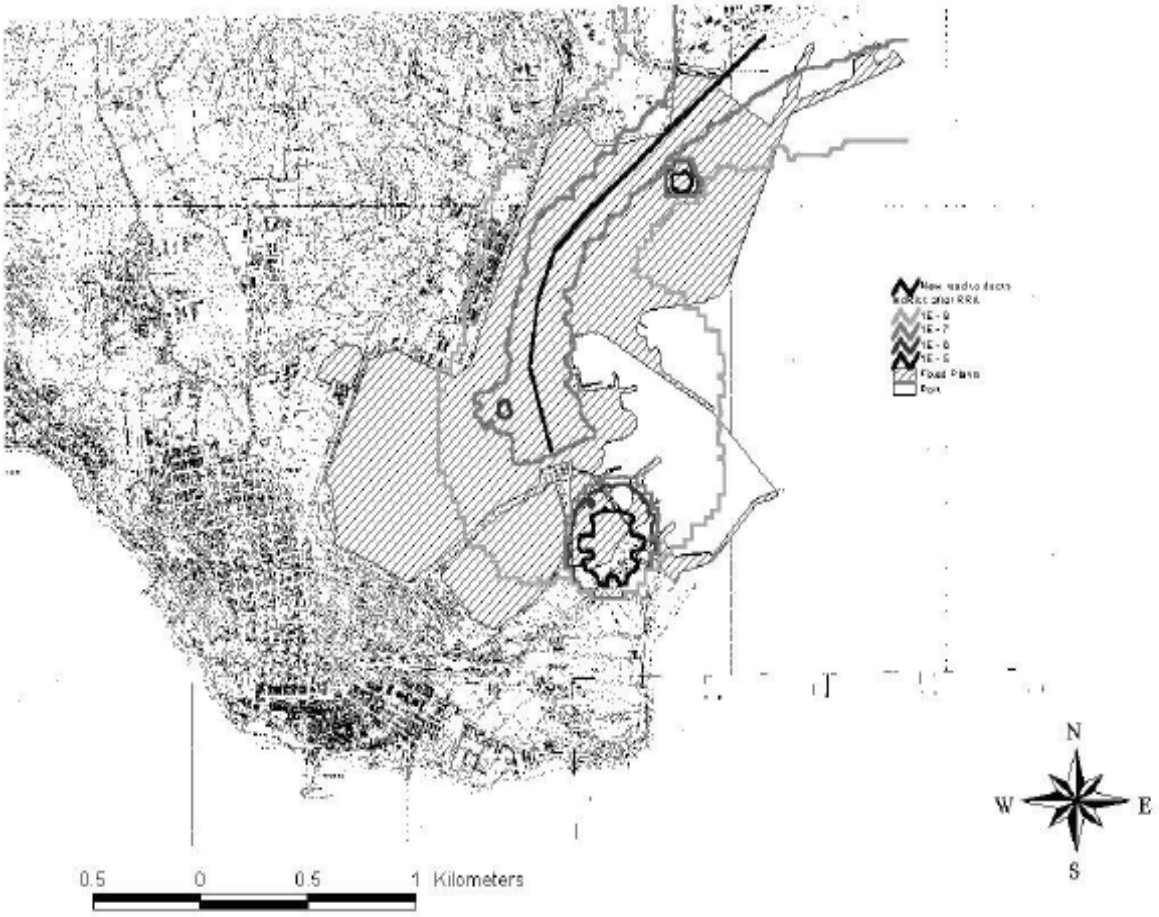

Fig 25 – Action 3: proposal of a new route for the transportation of dangerous substances (from Cozzani *et al* 2006)

The effects of the 4 risk reduction actions on the individual and societal risk indexes were calculated using the Aripar-GIS software. To estimate the impact of action 1, the average number of persons present in the vulnerable area corresponding to the docks was reduced, and a new "vulnerable target" corresponding to the new parking area was defined. The frequencies of accidents involving dangerous substances associated to the loading/unloading operations in the harbor area (risk sources n.14 and 15 in Table 18) were lowered from 5.10^{-7} to 5.10^{-8} events/year, in order to account for the higher safety that should be achieved clearing the area from touristy traffic. To simulate the effect of action 2, the risk sources due to the loading/unloading operations involving hazardous substances were moved to the position of the new docks. The risk sources due to the road transport of hazardous substances were modified to assess the effects of action 3. A new risk source due to road transport of hazardous substances was defined, corresponding to the new road collecting all the traffic of dangerous substances (Fig 25). The fixed risk sources due to ammonia (n.10, 11, and 12 in Table 18) were removed to simulate the effect of action 4.

The individual risk map after the four hazard reduction actions is shown in Fig 25. The calculated societal risk curve is reported in Fig 21. After the four hazard reduction actions the societal risk becomes very low and the individual risk in the residential areas of the town becomes

completely negligible. However, the four proposed action had completely different impacts on the two risk indexes:

- Action 1 had a limited effect on individual risk, but resulted in an important reduction of societal risk due to fixed risk sources (mainly those of the port area), as shown in Fig.21;
- Action 2 resulted in a significant modification of individual iso-risk contours, that caused the vulnerable target constituted by the touristy docks to decrease from a 10^{-6} to a 10^{-8} individual iso-risk zone. This caused the societal risk due to the fixed risk sources of the port to become negligible, as shown in Fig 21;
- Action 3 is the main cause of the important modifications of the individual iso-risk contours, as emerging from the comparison of Fig 20 and 25. This action confined iso-risk contours of individual risk higher than 10^{-8} inside the areas of establishments. After this action, also the societal risk becomes negligible;
- Action 4 did not result in any relevant modification of the individual and societal risks. As a matter of fact, the contribution of the ammonia accident scenarios to the risk indexes was negligible, since very low frequencies of ammonia releases were used in the QARA study (see Table 18) due to the high safety standards of the ammonia storage.

As shown in Fig 26, after the four hazard reduction actions the situation of the Piombino area becomes almost acceptable with respect to the French LUP criterion:

Fig 26 – Application of the French LUP criteria after the four proposed hazard reduction actions (from Cozzani *et al* 2006)

Action 4 (the elimination of the ammonia storage) eliminates the extended Z1 and Z2 protection zones due to ammonia releases. Only the residential area of Cotone is still within a Z1 zone. Both the Dutch and British risk based criteria show a complete compatibility of individual and societal risk indexes in the area after the four hazard reduction actions. Both criteria should not impose, after the risk reduction actions, any limitation to LUP in the Piombino residential areas. The 10^{-6} zone evidenced in Fig 23 is completely within the industrial area. Fig 27 shows the new inner, middle and outer zones defined by the British method:

Fig 27 – Application of the British LUP criteria after the four proposed hazard reduction actions (from Cozzani *et al* 2006)

Fig 28 shows the allowed land use destinations according to the Italian criterion after the mitigation actions. As shown in the figure, the Cotone area has still a land use destination (i.e. a vulnerability level) which is not acceptable, while the situation of the harbor becomes compatible:

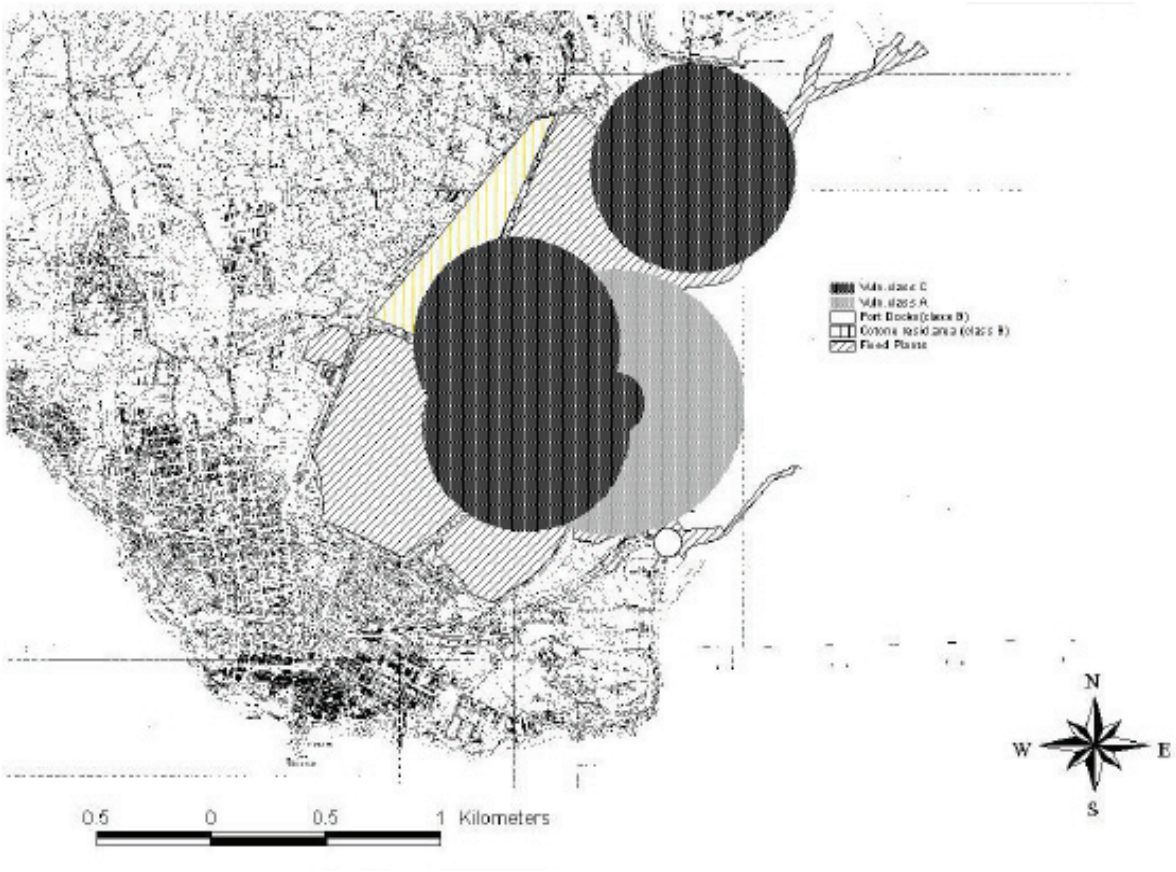

Fig 28 – Application of the Italian LUP criteria after the proposed four hazard reduction actions (from Cozzani *et al* 2006)

5.2.6 Critical comparison of the four land use planning methods: what the case-study tells us?

The results of the application of the four land use planning criteria to the same industrial area offer the opportunity to reflect on some of the most important issues addressed in this book. It has to be noticed that the comparability of the four methods is made possible by the fact that all of them refer to the same criterion of acceptability, i.e. the physical effects resulting from the exposure to dangerous substances: in all the applied methods, the rationale of the evaluation is estimating the physical consequences associated with the exposure to accidents and evaluating their acceptability against pre-defined criteria (individual and / or societal risk) for which acceptability levels are given. The evaluation of a number of proposed hazard reduction actions was also performed by means of the application of the same methods in order to provide a direct comparability of the situations pre- and post- hazard reduction.

In a "real case" further economical, environmental and societal considerations would be recommended before a definitive adoption of proposed hazard reduction measures. On the other hand, the case-study aimed at providing a clear comparison of the different methods used in the four countries for characterizing the risk of accidents and evaluating risk (hazard) reduction actions according to the adopted criteria, without developing any discussion over their feasibility and eventual implementation. The outcomes of the case-study are therefore intended to elaborate a

critical comparison of the four methods rather than recommending one or more hazard reduction actions.

The first important point to remark is that all the four methods indicated that the present situation of the area of Piombino *is not acceptable*. However, quite important differences can be found in the extension of the areas where restrictions should be imposed according to the different land use planning criteria.

The French consequence-based method resulted the most conservative, identifying protection zones much more extended than in the other three cases. As a matter of fact, even without changing the considered scenarios and adopting extremely conservative frequency values, the risk-based criteria do not identify wide protection zones. The application of the Italian hybrid criterion resulted in narrower protection areas only because no standardization is imposed for the selection of scenarios that should be considered in the analysis[420]. Results very similar to those of the French criterion would be obtained if the same scenarios were considered in the application of the two methods. In this respect, it is important to stress the relevance of the accident scenarios considered in the application of the two methods, which appears to be the main factor influencing the results of consequence-based approaches to land use planning.

The very conservative outcome of consequence-based methods has some disadvantages, in particular when applied to existing plants. Identifying too wide protection areas may have too high social costs and may cause the application of the LUP criteria to be unrealizable from a practical point of view. It is important to notice that consequence-methods are mainly sensitive to the amount of substances treated and / or stored within establishments, and less sensitive with respect to the improvements of the internal safety equipments and measures which are not affecting the inventory of dangerous substances[421]. The Italian method, which introduced frequency classes for each scenario, is a first step in this direction. However, the threshold values of the frequency classes of the Italian method are not optimized: no lower cut-off value is defined and a single probability class is defined for all accidental scenarios having a frequency $\leq 10^{-6}$ events/year[422]. In simple words, no importance is given to technical measures reducing the expected frequency of a top-event from 10^{-6} to 10^{-8} events/year. Thus, the French and Italian LUP methods do not directly encourage hazard reduction actions aimed at increasing the safety of establishments beyond the limits imposed by the legally binding risk tolerability thresholds[423]. A further limitation of these methods is that the hazards due to the transport of dangerous substances is not considered.

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[420] The scenarios to be considered in the Italian method should be directly obtained from the Safety Report, and no mandatory criterion exists on which scenarios should be analyzed (e.g. the catastrophic failure of the pressurized ammonia vessels was considered "of negligible frequency" and no consequence assessment was present in the P2 plant safety report: thus, in the application of the Italian method, this scenario was excluded). Differently, the application of the French method in place before the emanation of the new Law of 2003 imposed the selection of worst-scenarios for each accident considered. The different outcomes of the applications of the two methods lies therefore in the scenarios considered for planning purposes.

[421] This remark is relevant to the note above and becomes clearer by looking at Table 18. Whereas the French consequence-based method imposed the selection of the worst-scenario for each accident considered, the maximum amount of substance potentially involved was taken into account. This lead the method to be sensitive to the quantity of substance treated or stored within the establishment and less "permeable" to the safety equipments and measures aimed at decreasing the probabilities and consequences of relevant scenarios.

[422] Refer to the compatibility matrix provided by the DM 9 Maggio 2001 and reported in the country profile at Chapter 4.

[423] This remark underlines the lack, in the French and Italian legislations, of specific provisions requiring the implementation of principles such as the ALARP or BACT principles.

Concerning the Italian method, additional difficulties in the application of the method arise from the absence of official guidelines: it is not clear how to calculate the probability class of areas where overlapping iso-damage contours are present. This aspect is relevant in highly industrialized areas, as the one of the case study, where many risk sources are present simultaneously and several iso-effects contours are overlapping.

Coming to risk-based methods, the first point to remark is that their application is much more time-consuming and requires more complex tools than for consequence-based methods. On the other hand, QARA studies usually result in a very accurate representation of the industrial risk, and accurate methodologies and software tools are now available[424]. The individual and societal risk values obtained from these methods are very sensitive indexes to represent the industrial risk, although less easy to understand for the population than the safety or damage distances obtained from consequence-based approaches. However, the risk due to the transport of hazardous substances may be more easily assessable by means of the same methodology and tools than in the previous case.

In general, the application of the four methods to the present situation of the industrial area of Piombino confirmed that an effective representation of industrial risk can be obtained. However, the case-study pointed out the relevance of the evaluation of societal risk for identifying "risky situations" connected with the position highly vulnerable targets where more subjects are simultaneously exposed to the risk of accidents (in the case of Piombino, the port docks); the evaluation of the societal risk portraits the risk in the area in a more accurate way than by means of only the evaluation of the individual risk.

With respect to the results obtained for individual risk, it must be remarked that they are strongly dependent on the frequency values associated with the different accidental scenarios considered. Although even using very conservative hypothesis the results of consequence-based methods will never be obtained, the extension of the areas were land use restrictions should be imposed may be quite different if, for example, the standard scenarios and frequency values suggested by the purple book were used in the analysis[425]. On one side, this is a positive element: the improvements in plant safety are taken into account and encouraged by these methods. On the other side, a careful analysis of the frequency values used in the analysis should be performed, and a standardization of the risk assessment procedure is required to correctly use these methods. It must be remarked that the correct assignment of frequency values to accident scenarios is still an open problem, that is well known for introducing an important uncertainty in the results[426]. Another important point to remark is that if the frequency values associated to the top-events of a risk source are very low, the final risk indexes ignore it, regardless the severity of the possible consequences. This is the situation of the pressurized ammonia storage in the P2 plant of the case-study: no restrictions would be required after the application of risk-based methods, like its mounding or its elimination, even if the possible damage area of a catastrophic failure would be very extended.

With respect to the effects of the hazard mitigation actions, all the LUP methods examined indicate that after the proposed modification of risk sources and vulnerable targets, the situation of the Piombino area would be almost compatible with the various acceptability criteria. However, important differences were found in the effects of the different mitigation actions, and thus in the priorities that would be given to the planned modifications according to the different LUP methods.

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[424] Refer among others to V. Cozzani *et al*, "The use of Quantitative Area Risk Assessment techniques in land-use planning", in: G.A. Papadakis (eds.), *op. cit.,* 2001, p.411

[425] P.A.M. Uijt de Haag and B.J.M. Ale, 1999, *op. cit.*

[426] Refer among others to A. Amendola *et al* (1992), Uncertainties in chemical risk assessment: Results of a European benchmark exercise, The Journal of Hazardous Materials, Vol. 29, 347-363

Actions 1, 2 and 3 have a negligible effect if the French consequence-based LUP method is considered. However, action 4 (the elimination of the ammonia storage) results in a large modification of the protection zones, that causes the final situation to be almost acceptable. Thus, as expected, the French consequence-based criteria would be extremely sensitive to the reductions of the amount of substances present in the area. On the other hand, changes in the risk sources due to the transport of hazardous substances are not considered by the method, thus the effects of action 3 are not taken into account by the method. Furthermore, the very conservative protection zones generated when toxic releases are considered, deriving from the severe accidental scenarios considered in the French LUP method, make ineffective realistic modifications of the position of highly vulnerable targets as deriving from the application of action 1 (i.e. the construction of a "buffer" parking zone). Therefore, if the French LUP criterion would be applied in reality, action 4 (i.e. the elimination of he ammonia storage) would receive the highest priority. Moreover, the results of the French method show that the situation of the Cotone residential area is still not compatible. Thus, the method suggests that a further hazard reduction action on the gasholder of P1 plant (risk source n.3 in fig.1) might be more important than actions 1, 2 and 3.

Also with respect to the risk-based criteria the situation of the Piombino area after the mitigation actions would be compatible with respect to both the individual risk and societal risk acceptability criteria. However, the priorities of the mitigation actions are quite different. The individual risk index is mainly dependent on the expected frequencies of the accidental scenarios. Thus, the main responsible of the less extended protection zones due to hazard reduction actions is action 2 (separation of commercial and touristy docks with a decrease of accidental frequencies). Individual risk maps are also obviously dependent on the position of risk sources, thus action 3 (i.e. the construction of a separate route for the transportation of dangerous substances) would result in an important modification of iso-risk contours, although the risk values due to the transport of hazardous substances are not affected.

As shown in Fig 21, societal risk is a very sensitive and accurate risk index in order to evidence the effects of mitigation actions and the risk levels for the population. Actions 1, 2 and 3 results all in important modifications of the societal risk: actions 1 and 2 cause a strong reduction of societal risk caused by accident in the port area, while action 3 results in a reduction of societal risk caused by the transport of hazardous substances.

However, the results obtained also show a clear limit of the risk-oriented criteria. The elimination of the ammonia storage (action 4) causes a negligible effect both on societal and individual risk. This is due to the very low frequencies attributed to accidents involving ammonia release[427]. As extensively discussed in Chapter 3, a tolerability threshold is prescribed for risk-based criteria, usually represented by the individual risk of 10^{-6} events/year. Theoretically, if frequencies of accidental scenarios are below this threshold, no benefit is achieved from inventory reduction or elimination of the risk source, in spite of the severity of the possible accidental consequences. This suggests that the use of risk-based criteria for land use planning would require the identification of a set of minimum frequency values for reference accidental scenarios.

In order to present the conclusions of the case-study in a easy-reading way, Table 20 summarizes the relevance of the four hazard reduction actions to the four applied land use planning methods:

[427] Between $9.47 \cdot 10^{-7}$ and $1.00 \cdot 10^{-8}$ for continuous release; see Table 18.

Table 20 – relevance of the four hazard reduction actions to the four national methods

		PRIORITARY HAZARD REDUCTION ACTIONS (HRA)	REMARKS	SITUATION AFTER THE HRA
Risk-based methods	Dutch method	Construction of a "buffer" parking zone (act.1), a separated dock for commercial traffic (act.2) and a new transportation route for dangerous substances (act. 3)	Act. 1 and 2 are relevant to the separation of hazards and vulnerable targets; act. 3 is further relevant to a significant decrease of societal risk indexes	COMPATIBLE
	British method	Construction of a "buffer" parking zone (act.1) and a separated dock for commercial traffic (act.2).	Act. 1 and 2 are relevant to the separation of hazards and vulnerable targets	COMPATIBLE
Consequence-based / hybrid methods	Italian method	Construction of a "buffer" parking zone (act.1), a separated dock for commercial traffic (act.2) and elimination of the pressurized ammonia storage (Act. 4)	Act. 1 and 2 are relevant to the separation of hazards and vulnerable targets.	COMPATIBLE WITH the PARTIAL EXCLUSION OF THE RESIDENTIAL AREA OF COTONE (due to the P1 fixed risk source)
	French method	Elimination of the pressurized ammonia storage (act. 4)	The elimination of the fixed risk source eliminates the widest Z1 and Z2 protection zones	COMPATIBLE WITH THE PARTIAL EXCLUSION OF THE RESIDENTIAL AREA OF COTONE

As shown in the Table, risk-oriented methods give higher priority to actions aimed at increasing the separation between hazards and vulnerable objects. In the Dutch case, high priority is also given to the measure decreasing the societal risk connected with the transport of dangerous substances. This method appears hence to be the most comprehensive in terms of the set of actions to be taken. However, the risk indexes associated to the presence of a fixed risk source such as the ammonia storage are not affected by the eventual removal of the storage, being the frequency values associated to relevant scenarios rather small.

The Italian method appears to be in an intermediate position with respect to the priority of actions: though a strong relevance is given to actions 1 and 2 as in the previous cases, the risk associated to the presence of the gas holder (fixed source P1 in Fig 20) is still incompatible with respect to the residential area of Cotone. Here, further risk reduction actions would be required. The French method by its side would give highest priority to the removal of the pressurized ammonia storage (act. 4), which causes the widest protection zones in the area. However, in none

of these two cases the evidently relevant inauguration of a separate route for the transportation of dangerous substances would be considered as a priority action.

In conclusion, the application of several European LUP criteria to the industrial area of Piombino shows that important differences are present in the extension and type of land use restrictions that would be required after their application. A different priority of actions for hazard reduction actions would be also identified by the different methods.

In particular, consequence-based methods seem to be more conservative than risk-oriented approaches, and to be less sensitive to mitigation actions oriented to plant safety improvement and to the protection of vulnerable targets. On the other hand, these methods are extremely sensitive to actions involving the reduction of hazardous substance inventory. Moreover, differences in the scenarios considered in the analysis resulted in extremely large differences in the protection areas identified.

Risk-based methods appear to be more sensitive and more suitable to evaluate the effects of risk reduction actions and to promote higher safety standards in the operation of establishments. In particular, the societal risk index proved to be very sensitive to the effect of risk reduction or mitigation actions. However, the results obtained confirmed that the use of acceptability criteria based on threshold values of risk indexes strongly requires the definition of a standard set of minimum allowable frequency values for reference scenarios to obtain meaningful results.

It may be concluded that the different LUP criteria adopted in Europe showed a substantial agreement in the evaluation of the present and future situation of the case-study, but important differences were found in the identification of effective hazard reduction actions. In this perspective, the integration of some aspects of the various LUP approach, in particular the criteria used for the selection of accidental scenarios, could represent a useful contribution to the consolidation and harmonization of LUP criteria with respect to major accident hazards. This recommendation, deriving from the presented case-study, will be further discussed in the final Conclusions.

5.3 "Risky information": a comparison between the UK and The Netherlands recent developments

After the application of four of the five approaches to the matter of land use planning in areas subject to major risk it appears clear how the role of information (represented, in the previous case, by the collection and geographical representation of the QARA study together with the vulnerability of the industrial area of Piombino) is of primary importance during land use planning evaluation processes. In the previous case, one single tool (the Aripar-GIS software) and a pre-existing QARA study were used to perform the analysis. In reality, the collection and representation of information in the various countries would have been performed according to national practices.

This consideration led to perform a second comparative analysis aimed at highlighting the different role of information in general, and of risk-maps in particular, for supporting land use planning processes in two countries with a comparable method but rather different legislative background: the United Kingdom and The Netherlands[428]. As demonstrated by the previous analysis in fact, the representation of individual risk contours and, in some national contexts, of societal risk on a geographical information system (GIS) is a fundamental step for the visualization of at-risk situations and relevant land use planning evaluations. Furthermore, these information are an indispensable means of communication for informing the public over the risk it is subject to and

[428] C. Basta *et al* (2008), *op. cit.*

for combining, in a easily readable way, the information related to more type of risks simultaneously.

The relevance of the geographically-based representation of "risky information" has been object of a number of studies (Moen and Ale 1998, Zlatanova *et al* 2006)[429] and European projects (the already mentioned ARMONIA and Espon Hazard projects). Though a detailed analysis of the technical aspects of the GIS representation of risk-related information is out of the scope of this book, their use for supporting land use planning processes and for communicating the risk to third-parties is of certain interest for striving for the final conclusion of this investigation. This last aspect in particular is relevant to the scope of the Seveso Directives, and the analysis of relevant national practices is consistent with the intention of verifying the "limits and horizons" of the future European regulation.

In some European countries, the acknowledgment of the relevance of risk-maps for informing the public over major accidents risk led to the creation of regularly updated informative web-portals. As already mentioned, in France and The Netherlands it is possible to access multi-risk maps from the web-portals of the Ministry of Environment, in one case, and the Provincial authorities in the second case[430]. In the United Kingdom, such an informative platform was not in place at the time of the investigation. As this paragraph will discuss in fact, to different national regulatory frameworks and practices different information policies correspond. The investigation of these differences may be an other step towards the identification of recommendations for the future developments of the joint European regulation together with a useful reflection on one of the most fundamental requirements of the Seveso Directives, i.e. the obligation of informing the public.

As already discussed in Chapter 4, the United Kingdom and The Netherlands are the countries with a more similar approach to the matter of land use planning in areas subject to major accidents risk, mostly due to the common risk-based orientation of relevant legislations and the adoption, in both methods, of individual and societal risk criteria. Nevertheless, the legislative backgrounds of the two Kingdoms, their different geographical and demographical situations and their cultural orientations lead to some relevant differences in their MA risk prevention policies together with the use of risk-maps for informing planning processes. In order to facilitate the reading of the paragraph, the most relevant among them are recalled in the list below:

1. The status of the risk acceptability criteria: a strictly quantitative risk assessment (QRA) is required in the Netherlands, where legally binding thresholds for individual risk are prescribed by law. Differently, a judgmental approach based on the application of the ALARP principle applies in the United Kingdom;
2. A different definition of societal risk: strongly quantitative in the Netherlands, it is based on the integration of the individual risk figures with population data in the UK;
3. A different configuration of decision making processes, deriving from a different lay-out of the institutional systems: strongly centralized and focused on a unique Safety Authority in the UK, it is a multi-level system involving different institutional competences in the Netherlands.

[429] J.E.T. Moen and Ben Ale (1998), Risk Maps and Communication, Journal of Hazardous Materials, No. 61, 271-278.

[430] As before mentioned, to the creation of such national informative supports, the problem of the elaboration of a European harmonized and integrated "risk-maps" may be associated, also in consideration of the eventual transboundary effects associated to different kind of natural and technological events. "Mapping" major risks on a European scale and according to common used criteria is proposed among the results of recently promoted European research projects such as the before mentioned ARMONIA project (*op .cit.*)and the ESPON Hazard project (P. Schmidt-Thomé 2006, *op. cit*). The relevance of these projects to the recommendations given in this book will be further discussed in the final Conclusions.

Concerning the deriving risk-informative systems and the elaboration of risk-maps, most relevant differences are:

4. In the Netherlands, shared information platforms are used as reference for elaborating risk-maps and delivering risk data. The authority responsible for granting the license to Operators (which differs according to the classification of the plant within given dangerous categories) is also responsible for the regular update of the data. In the UK instead, the national Safety Authority Health and Safety Executive (HSE) owns the data, and it is entirely responsible for their regular update;
5. In the Netherlands, the information reported on risk-maps is extended to different kind of risks with a geographical relevance. Risk-maps are published on the Internet and accessible by indefinite end-users. The specific nature of the substances treated/stored within establishments and, until recently, iso-risk contours were available to consultation. In the United Kingdom instead, risk-maps report only iso-risk contours together with the level of associated risk or harm: no information is given regarding dangerous substances. Furthermore, risk-maps are directly delivered to the Planning Agencies by the (local offices of) HSE, without any direct communication of their content to the population.

5.3.1 Dutch risk-informative system[431]

As extensively discussed in Chapter 4, the Dutch spatial planning system involves three different levels of governance: the national, the provincial and the municipal levels. As in the majority of European territorial planning systems, the government establishes principles for spatial planning, defines building regulations and set-up long-term objectives for relevant urban and environmental issues[432]. All three tiers of government have independent planning powers, although the consistency requirement stated in the Dutch Spatial Planning Act has to be respected. The interaction between the tiers of government is characterized by consensus building and mutual adjustment. Hierarchical relations are rarely activated[433].

This multi-level governance system is reflected in the supervision of hazardous installations by the side of different authorities. The Ministry of Housing, Spatial Planning and the Environment (VROM) is competent for facilities of national interest, such as nuclear power plants (NPP) and nuclear waste disposal. Dangerous establishments falling under the Seveso II requirements are classified in accordance to threshold values considering the quantity of stored and/or treated dangerous substances. According to their classification, top-tier Seveso plants fall under the provincial competence and, in case of lower-tier plants and small LPG storages, under the municipal competence. Operators whose facility falls under the Seveso Directive are responsible for the elaboration of detailed quantitative risk assessment (QRA). The supervising authority validates the reliability of the analysis, and it is responsible for acquiring and updating all the information which is necessary to assess the compliance of the installation with the operational, spatial and environmental legal requirements. The described organization in the acquisition and validation of risk-related information responds to a multi-level system, reflecting the institutional decentralization of the country.

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[431] Mr. Bouwma (Provincie Overijssel) Mr. Manuel (RIVM) and Mr. Van der Zande (RIVM) are gratefully acknowledged for having provided part of the information reported in the current section.

[432] Refer among others to A. Van der Valk (2002), The Dutch planning experience, Landscape and Urban Planning No. 58, 201–210.

[433] For the reference of the Spatial Planning Act refer to Chapter 4. For an account of the Dutch spatial planning policy refer to A. Faludi and A. Van der Valk, *Rule and Order, Dutch Planning Doctrine in the 20th Century*, GeoJournal Library, vol. 28, Kluwer Academic Publisher, Boston, 1994.

As a consequence of this decentralization, until recent developments in the risk-information system geographical and industrial data related to Seveso establishments were spread out over numerous authorities. As a reaction to the Commissie Onderzoek Vuurwerkramp's report, appointed after the accident of Enschede occurred in 2000, a national scale overview of the risk posed by Seveso establishments had to be created[434]. Furthermore, the Seveso II Directive obligation of reporting major accident events to the European Commission Major Accidents Reporting System (MARS) posed the problem of centralizing the information relative to accidents. Finally, the need of informing the public had to find a translation into a systematic elaboration and delivery of geographically based risk-information. The most relevant initiatives in this respect were the development of the Installations Handling Dangerous Substances Database, managed by the Netherlands National Institute for Public Health and the Environment (RIVM), and the development of GIS risk-maps (Dutch *risicokaart*), which realization falls under the provincial responsibility.

With the development of the Installations Handling Dangerous Substances Database the authority responsible for granting the environmental license to the operator of a given hazardous installations is obliged to forward all relevant information to the database. The authority responsible for granting the license is the owner of the data and it is responsible for their validity.

As before mentioned, next to the development of the national database the issue of delivering risk-related information to different authorities and citizens in an easy-reading was addressed. Standing to the described Dutch land use planning criteria in the context of the Seveso II Directive, the visualization of the risk connected to an accident scenario results from the overlap between the selected reference scenario, its iso-risk contours and the vulnerability of the involved territorial and environmental context. The national Installations Handling Dangerous Substances Database is used as informative source for the elaboration of relevant maps by the side of provincial authorities, who refer also to the ISOR database. ISOR is the result of the cooperation between the 12 Dutch provinces, in which additional risk information such as flood risks and vulnerable objects are collected. Data in this database are owned by municipalities.

Thanks to these developments, previously spread out risk information have been converging towards a national d-bases and comprehensive and harmonized provincial risk-maps could be realized on a GIS platform. The variety and quantity of reported information is notable and comprise the localization of establishments, the amount and nature of substances stored and/or treated, individual iso-risk contours and the emergency planning in the area. It is important to point out that a recent model plotting societal risk (represented by FN curves) on digital maps was developed by the Dutch Applied Research Institute TNO[435]. A foreseeable evolution of risk-maps is therefore the integration of the societal risk contours in addition to the visualization of individual risk. Considering the legally binding status of the individual risk criteria in the Dutch legislation, individual iso-risk contours are suitable to inform the development of spatial plans, building development plans and single planning permission.

Beside this "institutional" utilization of risk-maps, in the Netherlands detailed risk-maps have been developed also as a means for informing the public about the risks present in their living environment. In accordance with the obligation of informing the citizens about the risk of major accidents stated in the Seveso Directive and further embodied by national legislation, risk-maps are accessible via the Internet. Even in this case the amount of reported information is notable. End-users can access information about the location of hazardous installations, the hazardous substances that are used or produced, risks related to transport and the vulnerable objects in the area. The

[434] Commissie Onderzoek Vuurwerkramp, *De vuurwerkramp. Eindrapport*, Phoenix en Den Oudsten, Rotterdam, 2001

[435] T.Wiersma *et al*, *Gebiedsgericht groepsrisico Groepsrisico op een kaart*, TNO Report, Apeldoorn, 2005.

understanding of this information is supported by a detailed legend. Other kind of risks like panic in crowd and main aircraft routes are illustrated. This public version of risk-maps do not allow any elaboration of the information by the side of end-users and serve only for illustrative purposes. Nevertheless, end-users can select different layers with the information of interest and visualizing more or less accurate data. An example of public risk-map is reported in Fig 29.

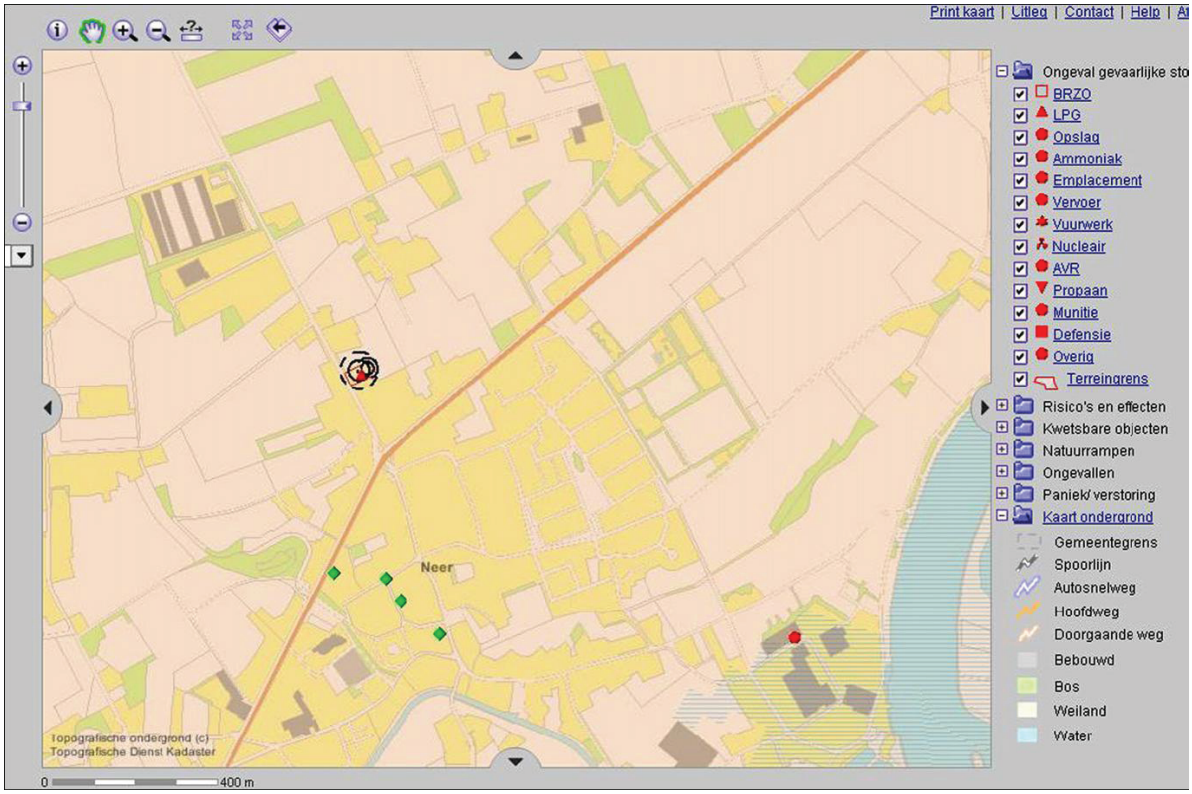

Fig 29 – risk-maps of the Province of Limburg (retrieved from www.risicokaart.nl)

Until the end of 2005, iso-risk contours were also reported in the provincial web-site and had a prominent communicative relevance. Strong of its information accessibility tradition, the underlying intention of the Dutch government was delivering easy-reading geographical information to the public and complying, in so doing, with the Seveso II requirements and relevant national policies[436]. Interestingly, although the accessibility of risk-information was responding to a requisite of transparency, a conflict with the increased European security requirements followed. The European communication of 2004 regarding the protection of critical infrastructures in the fight against terrorism underlined how all those "[..] *physical and information technology facilities, networks, services and assets which, if disrupted or destroyed, would have a serious impact on the health, safety, security or economic well-being of citizens or the effective functioning of*

[436] In particular, the already mentioned guidance issued by the Dutch Ministry of Environment VROM, *Handreiking ruimtelijke ordening en milieu voor ruimtelijke plannen*, Den Haag, 2005

governments in the Member States [...]" should be carefully monitored and protected[437]. The European Communication stressed the need of enhancing the elaboration and the exchange of information relative to critical infrastructures threats among public and private actors. Above all, it stressed the need of increasing the discretion in their dissemination. Being Seveso chemical establishments responding to the definition of physical critical infrastructure, a conflict between the accessibility of risk-information and the security of the population had to be considered.

This issue opens an interesting reflection about the so-called "citizens' right to know" and the obligation of informing the public stated in the Seveso Directives. The fulfillment of this fundamental obligation under the unexpected circumstance of international terrorism threat seemed in fact to be in contrast with the higher security standards required for protecting European citizens. It may be said that, after the wanted transparency and safety increase corresponding to the elaboration and delivery of detailed risk-related information, an unwanted security decrease could have followed[438]. The impossibility of quantifying the amounts of "safety increase" and "security loss" associated to the publication on the Internet of risk-maps was at the centre of a lively a political debate within the Dutch government. The debate led to the cancellation of iso-risk contours from the risk-maps delivered on the Internet, as proposed by the cabinet on September 9, 2005, on the basis of the assumption that "[…] *currently, security is more important than indefinite access to public government information* […]"[439].

Interestingly, initially Dutch provinces refused to deny the access to iso-risk contours via the Internet. Their motivation was based on the assumption that accessing risk-information played a role in the improvement of citizens' coping-capacity, and that the adopted risk information policy was in line with citizens "right to know". Nevertheless, after January 1, 2006 iso-risk contours were cancelled from the web. Currently their consultation by the side of the public is subject to a specific procedure.

5.3.2 United Kingdom risk-informative system[440]

The UK approach to the matter of land use planning in areas subject to MA risk was discussed in Chapter 4. As already mentioned, the central role of the national safety authority Health and Safety Executive is two-fold: on the one hand, it advices Local Planning Agencies (LPAs) on the Hazardous Substances Consent (i.e. installation and/or modification of Seveso II plants), while on the other hand it gives advice on the compatibility of proposed territorial developments with regard to existing situations. This second advice is carried out by personnel of the local offices of the HID Directorate and it is supported by a codified system known as Planning Advice for Developments near Hazardous Installations (PADHI), a software that came into force in 2002 in order to facilitate and speed the advising process and which was recently upgraded to the version PADHI+.

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[437] European Commission, COM (2004) 702 final, *Critical Infrastructure Protection in the Fight Against Terrorism*.

[438] It is important to account that in the English language *safety* corresponds to the prevention of the consequences of involuntarily provoked events, while *security* corresponds to the prevention of consequences of voluntarily and maliciously provoked events. This distinction is not mirrored in all European languages.

[439] Dutch Cabinet, *Kabinet wil effectafstanden risicokaarten van Internet*, Press Release Ministerraad, 9 September 2005, online. Available at http://www.regering.nl/actueel/nieuwsarchief/2005/09September/09/0-42-1 42-70961.jsp .
Last visited: March 2006.

[440] Miss H. Balmforth (HSE) is gratefully acknowledged for having provided the risk-map reproduced in this section.

PADHI leads to the outputs "ADVICE AGAINST" or "DON'T ADVICE AGAINST" on the basis of both risk analysis data (scenarios, risk contours and/or effects areas) and territorial data (type of targets, proposed developments' sensitivity level, population data)[441]. Notably, the HID has no enforcement power: it is entirely under the responsibility of Planning Agencies, which are competent for local land use plans, whether to implement the advice deriving from the PADHI procedure. This advisory role of HSE with respect to planning authorities reflects the nature of UK Health and Safety system, based on a great autonomy of local authorities on the one hand, and on an efficient cooperation among different governmental agencies on the other hand.

According to this configuration of the decisional process, the two phases of risk assessment and risk reduction are clearly distinguished: LUP decisions may, theoretically, exceed the safety advice both towards a major than a minor safety level. Practically, HSE advices are followed in the large majority of cases and are implemented by LPAs in the almost totality of land use plans[442]. The HSE advice is delivered to LPAs in form of risk-map, where the three inner, middle and outer iso-risk or iso-harm areas are represented on the relative cartographic base. As in the Netherlands, both the individual and the societal risk are used as criteria. Differently, the societal risk is not derived from a probabilistic calculation of the number of people potentially exposed to the consequences of accidents, but results from the integration of individual risk figures with population data. Here, densely populated areas and specific vulnerable targets (hospitals, schools, etc.), are considered in order to integrate the judgment resulting from the individual risk criteria. Interestingly, this type of estimation of the societal risk involves a major attention for the vulnerability of the subjects exposed to the risk of accidents, as indicators such as their daily permanence into buildings, age and health conditions are used for characterizing their actual sensitivity to the consequences of accidents.

The necessity of monitoring the population taking into account the mentioned indicators led to the development of a national database representing the population distribution and "mapping" relevant vulnerability levels on a geographical information system[443]. The creation of the database was commissioned by the Methodology and Standards Development Unit (MSDU) of the HSE in 2002[444]. The information collected in the database are owned and managed by HSE and no direct public access is allowed.

As mentioned before, HSE has initiated a review of the method used for supporting land use planning processes and delivering relevant advice to LPAs in 1998[445]. The review aimed at clarifying whether HSE role and methods were still valid, robust and in line with broader governmental policies for land development. One of the outcomes of the review was the proposal of developing a modified version of PADHI enabling LPAs to carry out risk-related LUP assessments independently. The project has been carried out by the Geographical Information Systems team of the Risk Assessment Section of HSL. Within the project, a scoping study involving volunteer LPAs and addressed to explore the format of the HSE advice that could have replaced the ordinary paper format was carried out and published in 2005[446]. Results outlined that a GIS format for risk-maps (called, in the document, "3 zone map") was preferred by LPAs, as they

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[441] Refer to HSE (2005), *PADHI. HSE's Land Use Planning Methodology*, online. Available at http://www.hse.gov.uk/landuseplanning/padhi.pdf . Last visited: April 2008

[442] C. Basta *et al* (2008), *op. cit.*

[443] Refer to G. Smith et al (eds.), *A national population database for major accident hazard modeling*, HSE Research Report 297

[444] *Ibid*

[445] HSE (2005), *Implementation of the Fundamental Review of LUP*, *op. cit*.

[446] H. Balmforth, *Scoping study for 3 zone map delivery to Local Planning Authorities*, HSL Research Report RAS/05/01, 2005.

would have had the opportunity of updating their existing database with compatible format data[447]. An example is reported in Fig 30:

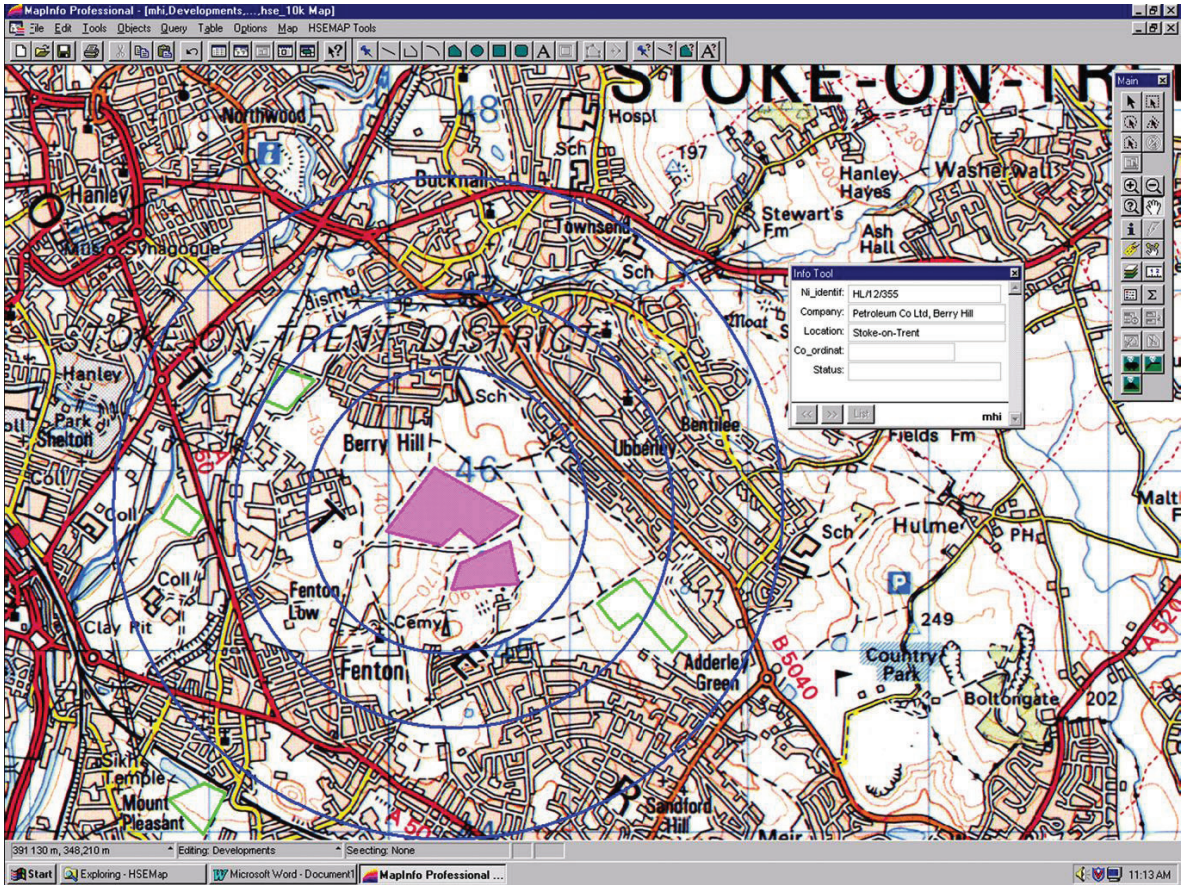


Fig 30 – example of three-zones risk-map (after Balmforth 2005)

Differently than in The Netherlands, the reported three-zones risk-map doesn't reveal neither the nature of the substances involved in the represented scenario nor the presence in the area of other forms of natural or technological risks. The amount of information is reduced to those necessary to advice LPAs to assess the compatibility of the three inner, mid and outer zones with respect to the targets falling into their iso-risk or iso-effects contours. Furthermore, these risk-maps are not intended as a means suitable to inform the public: their consultation by the side of third-parties is subject to a specific procedure, which may imply the presentation of motivations for which they want to access them[448]. As a result of the IFRLUP project, during the course of 2006

[447] The need of facilitating the advice procedure by means of geographically based information emerged from the relatively frequent update of risk-maps by the side of HSE. Each time HSE assessment involves some changes in the risk contours or new developments in the vicinity of installations are realized, new risk-maps has to be forwarded to LPAs. Hence, evolving to a GIS format represented a natural step of the advice procedure. Other findings of the scoping study were the preference, by the side of LPAs, of the representation of the three-zones in three different GIS layers instead on one layer with three different zones, in order to allow the "switch off" of different harm/risk areas when desired.

[448] HSE (2005), *op. cit.*

HSE's risk-maps had been stored on a secure electronic server, accessible by LPAs by setting up a user profile. Citizens are not granted access to this "map library", which consultation is subject to specific and motivated request.

5.3.3 Remarks and conclusions

In both the examined countries, the potentials of geographically based risk-informative systems to represent major accident risks at national scale is evident. Furthermore, the appropriateness of shared data base to connect different institutional actors during decision making processes is of outstanding evidence. In both countries, risk-maps are becoming more central to local risk prevention practices and GIS databases storing the great amount of data regarding the national risk situation have recently established. Although differences in the two risk regulations led to the development of different forms of cooperation among the various competent authorities, a good connection between the operational competences of Safety and Planning Authorities seems to be achieved.

A notable difference between the two examined countries regards the possibility of accessing risk-maps by the side of the public. In the Netherlands, a notable amount of risk information is available for end-users through the Internet. In the UK, although the transparency of decisional processes is guaranteed by the public status of the information, risk-maps can be accessed by the public only after a specific request. This remarkable difference cannot be explained in a univocal way. A first explanation might be a different interpretation of the threat represented by the availability of information regarding the existence and localization of chemical sites in the national territories. Evidently, a different estimation of resulting security threats and a different priority assigned to the accessibility of information ground the choice of limiting or allowing the access to risk-maps by the side of public.

In this perspective, a different priority between the obligation of informing the public and the confidentiality of the information about the risk associated to Seveso establishments had been assigned. Furthermore, the necessity of increasing national security standards had been differently interpreted in the two countries: in the Dutch context, the obligation of informing the public has not been sacrificed to the increase of national security, while in the United Kingdom the access to the same kind of information appears to be subject to major restrictions.

Here, a different interpretation of the precautionary principle can be brought into discussion, although the investigation didn't retrace any explicit mention of the principle as a justification of the two different policies. In the Dutch case, where the delivery of risk information to unknown end-users could theoretically lead to an uncontrollable and not estimable decrease of security, a more precautionary approach would be in conflict with the adopted transparent informative policy. In the United Kingdom, a major concern seems to regard the confidentiality of industrial information and the protection of the population from the threat of terrorism. With regard to second issue, in consideration of the impossibility of foreseeing the eventual misuses of the information delivered by means of risk-maps to unknown end-users, a more conservative approach seems therefore to apply. Both choices have a consequence in terms of balance between security and transparency. In the Dutch case, this balance hangs for transparency, with a governmental exposure in terms of liability with respect to citizens. In the United Kingdom instead, the "right to know" of citizens is not interpreted as the unilateral delivery of risk-related information by the side of Authorities and the balance, implicitly, seems to hang for security.

A second and probably more realistic explanation of the two different information policies might be the historical heritages and cultural backgrounds of the two countries. In the United Kingdom, terrorism has been a concrete threat along the past four decades, from the attacks of the Irish organization IRA up to the terrorist attack of Al Qa'ida in London in the summer of 2005.

These experiences, combined with the traditional confidential attitude of the United Kingdom culture, may justify the tendency of protecting information subject to potential and eventually harmful misuses. Differently, in the Dutch history of the last decades terrorist attacks have been of scarce relevance. The Dutch risk prevention policy developments discussed in Chapter 4 show that the attention given to inform the public lies in the long history of accidental events and natural catastrophes occurred within densely urbanized areas. In the Dutch geographical and demographical context, the awareness of the population with regard to major risk is a key factor of prevention. This may explain the tendency of facilitating the access to risk-related information, although some restrictions were imposed after the need of increasing security was acknowledged at both European and national levels.

Coming back to the desirability of national risk-informative systems and the suitability of risk-maps for informing land use planning processes, the creation of geographically-based information platforms wherein the risk associated to Seveso establishments may be reported and periodically updated on a national scale while being accessed by intermediate and local authorities seems to be the advisable frontier of European risk prevention systems. In consideration of the establishment of the European Major Accidents Reporting System (MARS)[449], mentioned in Chapter 3, and the creation of a European database of accidental scenarios for supporting Member States in their land use planning evaluations, the realization of nationally centralized databases collecting the information spread among various authorities and across the various levels of governance seems recommendable. As deriving from the Dutch experience, in order to support land use planning processes according to the various kind of risks which may be present in the same area, such "risk libraries" should collect information over technological as well as natural risks. As demonstrated by the scoping study promoted by HSE to investigate the suitable format of such information, geographical information systems (GIS) offer a valuable support for allowing both the simultaneous representation and an easy updating of data.

5.4 Different methods for different levels of prevention? Some ethical considerations

After this having reached a more insightful understanding of some European major accidents risk prevention policies and the relevant land use planning methods I would like to address some ethical considerations referring to the analysis developed in Chapter 3. In order to facilitate the reading of the present paragraph, part of Table 6 is reproduced:

[449] Refer to Chapter 2.

PRIMARY OBLIGATION	OPERATORS		AUTHORITIES	
Preventing the risk and minimizing the consequences of major accidents	Implementing appropriate safety measures on the basis of the provided criteria		Defining a risk-acceptability level and / or acceptance criteria (risk levels, ALARP, CBA, multi-attribute, land use planning requirements, etc	
RESIDUAL OBLIGATIONS	*Related to risk existence*	*Related to harm*	*Related to risk existence*	*Related to harm*
Obligation to improve	Implementing ALARP, BACT and related principles to safety management	Implementing *lessons learned* from accidents to improve the satisfaction of the primary obligation	Keeping decreasing risks associated to exposure (land use planning) and improving emergency response instruments	Implementing *lessons learned* from accidents to improve the satisfaction of the primary obligation
Obligation to communicate	Delivering information about risks	Delivering information about accidents	Communicating information over risks	Communicating information over accidents

In the Table, the primary obligation decaying from the scope of the Seveso Directive and the two residual obligations of communication and improvement are evidenced. These two obligations are those I would like to reflect on more in depth, now that a clear description of five European approaches to the matter of MA risk prevention was given. The questions I would try to reply to is: assuming that all analyzed policies are fulfilling the primary obligation stated in the scope of the Seveso Directives, is this obligation *equally* fulfilled? Furthermore, do the two residual obligations of information and improvement find an equal translation into the analyzed policies?

A first reply is surely *yes*: the primary obligation stated in the scope of the Seveso Directive found a different operational translation in national MA risk prevention policies, but in consideration of the comparable results obtained from their application to the case- study, they can be considered equally in line with the scope of the Seveso Directive. Nevertheless, by looking at the different priority given to different hazard reduction actions in the same case-study and at the brief comparison of two representative national informative policies and systems, it can be concluded that the obligation of communication and improvement are fulfilled differently.

The first and second remark is confirmed by the case-study reported in section 5.2, where different LUP criteria were compared; here, all methods agreed on the unacceptability of the risk situation of the area of Piombino. Nevertheless, the priority of actions required by the different criteria for *improving* the situation in the area resulted to be rather different.

With regard to the obligation of information, a different approach emerged from the analysis reported in 5.3, wherein two information policies were briefly investigated. Here, the obligation of information is evidently interpreted differently, being the status of information and their accessibility by the side of third-parties differently regulated in the two analyzed countries. The primary obligation stated in the Seveso Directives and the obligation of improvement will be

therefore analyzed recalling the results of the Piombino case-study; the obligation of information will be discussed referring to the comparison developed in section 5.3.

The primary obligation stated in the scope of the Seveso Directive has been defined recalling the text of the regulation, i.e. *preventing the risk and minimizing the consequences of major accidents involving dangerous substances*. As demonstrated in Chapter 4, Member States have "translated" this obligation in different methodological approaches, which may be generally categorized as risk-based and consequence-based approaches. As demonstrated in the case-study of Piombino, the adoption of these two approaches leads to rather different characterizations of risk; furthermore, it leads to prioritize different hazard reduction actions. In order to reflect on this important issue, I would focus on two of the four analyzed methods, namely the French consequence-based and the Dutch risk-based methods.

As shown in Fig 22, the application of the French land use planning criteria before the new law of 2003 led to the definition of the widest protection zones. Within this zones, the residential area of Cotone was included. Furthermore, the criteria led to prioritize the hazard reduction action aimed at decreasing the presence of fixed risk-sources, in this case the ammonia storage. The method revealed in fact to be "sensitive" to the inventory of dangerous substances in the area rather than to the safety systems and equipments in place within dangerous establishments. Furthermore, the method focuses on the evaluation of individual risk as the primary criterion for defining protection zones.

As evidenced by Fig 21 reporting the calculated FN curves and as deriving from the calculation of individual risk reported in Fig 20, the application of the Dutch land use planning criteria led to the individualization of rather "smaller" protection zones. In consideration of the frequency values associated to relevant accident scenarios, the individual risk associated to the ammonia storage was negligible. In this regard it can be said that the risk-oriented criteria enforced by the Dutch legislation "captured" the level of safety of the ammonia storage in terms of the likelihood of accidents potentially arising from it, in so doing providing a more detailed information to decision makers with regard to the definition of protection zones. The criteria led hence to prioritize actions aimed at separating hazards and exposed people rather than eliminating risk-sources, among which two of the most important would be constructing a "buffer" parking zones between the harbor and the establishments and inaugurating a separate route for the transport of dangerous substance. Both actions decrease the societal risk level in the area[450]. In summary, the Dutch method revealed to be more sensitive to the safety standard of establishments, and to the prioritization of hazard reduction actions aimed at decreasing the vulnerability of the exposed targets.

In the hypothetical circumstance of a strict application of the mentioned criteria to the area of Piombino, the French method would have, essentially, decreased the amount of dangerous substances present in the area. The somehow paradoxical consequence of this action, based on a consequence-based method, is that the *probability* of the consequences of accidents would have been nullified. The Dutch method would have instead maintained the same conditions for what regard the presence of dangerous substances, but would have profoundly modified the configuration of the surrounding context. This actions, deriving from a risk-oriented method, rather than decreasing the *risk* of accidents would have minimized their expected consequences by means of a decrease of vulnerability. Recalling an expression which was used in the Introduction, it can be said that whereas the first method applies a vision *from the establishment to the territory*, the second applies a vision *from the territory to the establishment*.

[450] Notably, both the French and the Italian criteria demonstrated to be less sensitive to the first action and not sensitive to the second one, being the transport of dangerous substances and the societal risk criterion not accounted in relevant policies.

This different prioritization of hazard reduction actions and the resulting territorial modifications of the area of Piombino represent the key results of the case-study and are of primary interest for the scope of the present analysis. Having assumed that both methods are in line with the scope of the Seveso Directives, it is interesting to argue on the consequences of their applications in terms of the effective *improvement* they would promote in the Piombino area in consideration of the requirements stated of Art. 12, i.e. *maintaining appropriate distances between establishments and vulnerable targets in the long-term*. Which of the two actions accomplishes the primary obligation of preventing the consequences of accidents *in the long-term* while satisfying, in so doing, the obligation of improvement more effectively[451]?

In consideration of the assumptions made so far, the Dutch method may reveal to be more effective with respect to both obligations. By looking at the interventions it promotes, a vision *from the territory to the establishment* appears in fact to be applied. The set of decisions deriving from the application of the Dutch criteria, namely the individual and the societal risk, leads to a structural modification of the area of Piombino and to an effective decrease of the vulnerability and exposure of targets in the long term. In so doing, the Dutch method seems to "improve" the situation of the area more consistently with the objective stated in Art 12 than the French one. The French method would in fact not create any long-term decrease of the vulnerability of the area of Piombino. By contrast, it would promote the permanent elimination of one risk source. However this sort of "punctual" intervention would not create the pre-conditions for a major compatibility of the others risk-sources with respect to the presence and transit of a large number of people in the area. Though the elimination of the ammonia storage represents a sure long-term benefit in terms of the decrease of the risk of accidents in the area, this action has a sort of "punctual effect" opposed to the "integral effect" of the actions promoted by the Dutch method. Furthermore, considering the eventuality of further modifications and / or increase of the level of risk in the area due to a change of the inventory of dangerous substances, it appears evident that the decrease of the *extrinsic* and the *intrinsic* vulnerability of targets promoted by the Dutch method represents a more effective accomplishment of the scope of Art. 12. Finally, the major sensitivity of the French method with regard to the dangerous substances inventory rather than to the safety performance of establishments doesn't represent an incentive for Operators for improving their safety management, but rather for decreasing the amount of substances treated or stored within them up to a minimum level of compatibility which may easily omit the implementation of principles such as the ALARP one. By focusing on the amount of substances rather than on the safety management of establishments and by promoting a major attention on inventories than on safety systems, the French method appears to be less efficient than the Dutch one with respect to the obligation of improvement.

In conclusion, the Dutch risk-oriented method has provided a more detailed "picture" of the risk posed by dangerous installations in the Piombino area by "capturing" the level of safety of Seveso establishments and by considering the risk associated to the transport of dangerous substances and the societal risk level in the area. In so doing it has demonstrated to be more effective with regard to the promotion of long-term and integrated hazard reductions actions. In the context of this analysis, such actions can be interpreted as a more efficient accomplishment of the residual obligation of improvement, as they promote a structural territorial modification of the area of Piombino and the decrease of its vulnerability to the consequences of a wider spectrum of accidents.

[451] The reply to this question is rather complex and it is, necessarily, based on a series of deliberate and somehow forced assumptions: in reality, the set of decisions deriving from the application of the two methods would be more variegate and complex than those here reported. The reply is therefore less grandiose from an operational perspective but is surely interesting from a theoretical one.

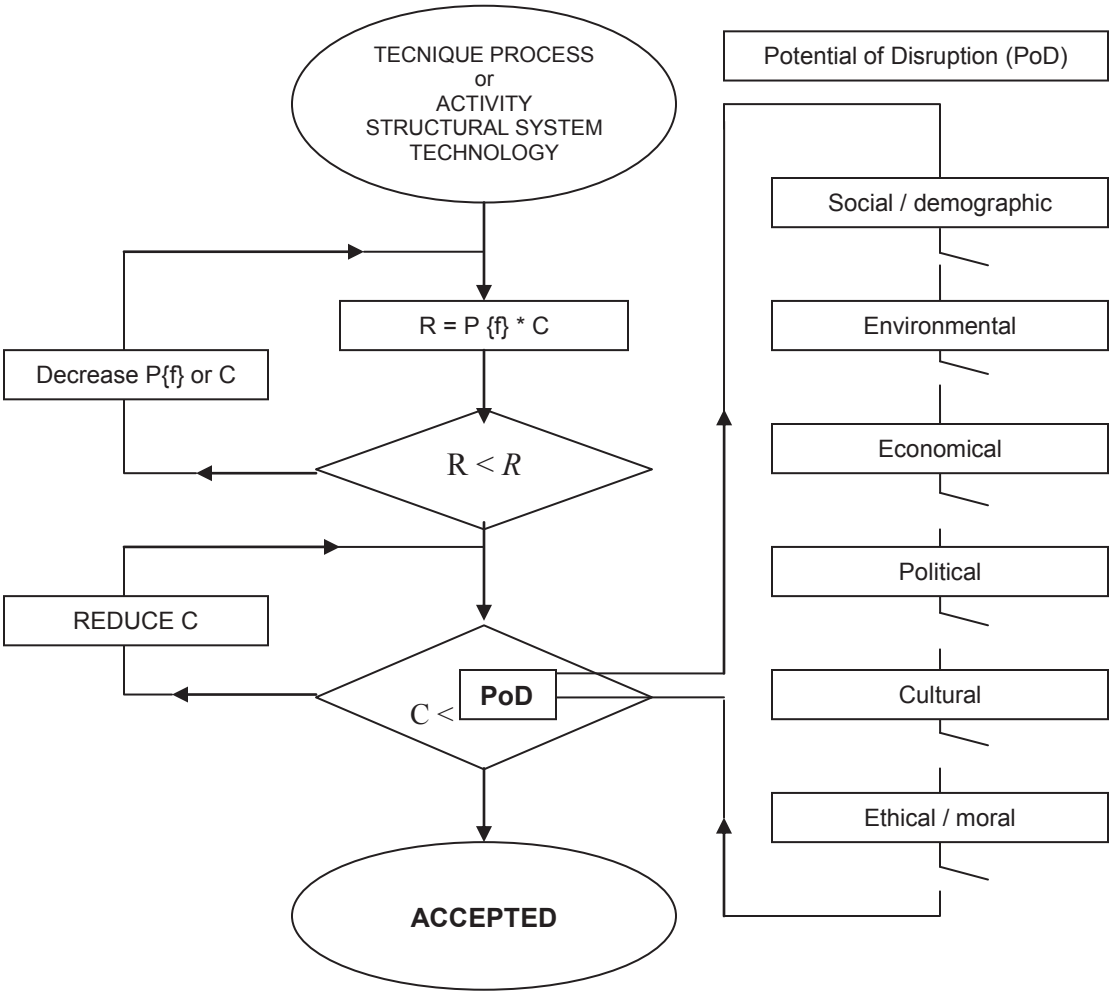
The application of the French method, by its side, offers the opportunity to reflect on the matter of low risk / high consequences accidents, represented in the case-study by the scenarios associated to the ammonia storage. In order to facilitate the discussion of this important issue I will report part of Table 18, where the different accidents scenarios and their probabilities is reported below. As shown in the Table, the scenarios which are accounted by the French method have a very low probability, which in the case of continuous release are in the order of 10^{-8} events / year. Protection zones of 60 meters for the Z1 and of 450 meters for the Z2 zone are prescribed.

Source n.	**Substance**	**Scenario**	**freq.** (ev/year)	*French Method* (protect. Zones)	
10	Ammonia	Inst. Release	-	1165	2140
11	Ammonia	Cont. Release	$3.03 \cdot 10^{-5}$	-	-
	Ammonia	Cont. Release	$1.00 \cdot 10^{-8}$	60	450
12	Ammonia	Cont. Release	$9.47 \cdot 10^{-7}$	-	-

As before mentioned and as demonstrated by the application of the Dutch and the British criteria, the "threshold of acceptability" above which risks are considered negligible in most of European risk-oriented regulations is of 10^{-6} events/ year: the French criteria would have therefore considered scenarios with a probability of occurrence of a considerably low value. Nevertheless, the avoidance of these scenarios in the area would be given priority in the case of their strict application. Is this priority in line with the ultimate scope of improving the safety in the area?

At the scope of arguing on this important issue further I would recall the model of van Breugel reported in Chapter 1. Here, the acceptability of low probabilities / high consequences events are assessed against a multi-dimensional criterion, reassuming the PoD (potential of disruption) of, among others, the environmental, demographical and economical systems which could follow the occurrence of such events. Though it is out of the scope of the present paragraph to perform a detailed application of this multi-dimensional criterion to the ammonia scenarios of the case-study, it might be interesting reflecting on its application on a qualitative basis and, above all, arguing on the minimization of PoD which would derive from the elimination of the ammonia storage (French case) in comparison to the PoD minimization which would be promoted by structural territorial modifications in the area (Dutch case).

In order to facilitate the reading of the section the model of van Breugel reported in Chapter 1 is reproduced below. As before explained the model of van Breugel focuses on the consequences associated to risk scenarios and provides a framework for their evaluation in a multi-dimensional perspective. The comparison of the French and Dutch methods could be therefore performed by focusing on the reduction of consequences of accidents (second part of the diagram) which would be achieved according to the different priority of actions derived from the Piombino case-study. The main question here is the same introduced at the beginning of this section: which of the two set of actions better improves the safety in the area and, in so doing, minimizes the PoD which could follow the occurrence of accidents?



In order to provide some qualitative replies to this question, it is important to keep in mind that the French method accounts only the consequences associated to the accidents arising from Seveso establishments, whereas the Dutch method accounts both the individual and societal risk associated to Seveso establishments and to the transport of dangerous substances. In this regard, it can be said that the Dutch method already accounts more "dimensions of risk" than the French one, as it covers a wider set of accident scenarios while considering the likelihood of groups of people transiting in the area of being involved. With respect to this different orientation (deterministic *vs*. probabilistic) it is important to notice that, by applying the Dutch approach, the first part of the diagram (R < *R*) would result in a negative outcome with respect to the rejection of the ammonia storage, whereas it results in a positive outcome by applying the French criteria.

Let's now evaluate the minimization of PoD which would derive from the elimination of the ammonia storage in comparison to structural land use modifications in the area. "Computing" the reduction of consequences in the first case, it may be questioned whether the PoD of the whole environmental, demographical and economical system of the entire area of Piombino is effectively minimized, being the action a "punctual" intervention which has practically no effect on the rest of the area and, above all, on the minimization of consequences associated to the accidents provoked

by other risk-sources. "Computing" the reduction of consequence in the second case, it is expectable that the modification of the land use destinations in the area by means of a new "buffer" parking zone and a new route for the transport of dangerous substances would result in a more effective minimization of the PoD with regard to the complexity of the environmental, demographical and economical system of Piombino: these actions in fact have an "integral" effect on all risk-sources present in the area and, in so doing, represent a set of long-term preventive interventions.

In conclusion, though the analysis is based on a series of deliberate assumptions, in consideration of the very low probability of ammonia scenarios *the prioritization* of the elimination of the storage in place of the introduction of long-term land use planning interventions affecting a wider set of accident scenarios shall be questioned. The residual obligation of improvement seems in fact to be better accomplished in the second case. Here, the fundamental ethical, but also methodological issue, is whether the *non* consideration of the probabilities of accident scenarios in the context of a mono-dimensional risk evaluation is effectively more *precautionary* than their consideration also in those cases in which their value is very low.

As deriving from the reported analysis, my conclusion is that such approach should find application only in those cases in which the consequences associated to accidents and the potential of disruption of the involved system in a multi-dimensional perspective are effectively *higher* than the *residual* consequences achieved by means of probabilistic considerations. In a different form, and referring again to the case-study, it may be concluded that prioritizing the elimination of a risk-source with respect to other hazard reduction actions on the basis of deterministic considerations is justifiable only in those cases in which the consequences of the relevant scenarios, once evaluated against a multi-dimensional criteria, are more severe than those minimized by such actions.

In conclusion, in front of the dilemma represented by opting for one of the two sets of actions, both based on a mono-dimensional characterization of risk, a multi-dimensional risk evaluations should follow. Whereas the outcome of a multi-dimensional evaluation hangs still in favor of the unacceptability of the consequences associated to a risk-source, it is assumable that the primary obligation of the Seveso Directives, together with the obligation of improvement, is better accomplished by means of its elimination: this action should be therefore prioritized. Whereas the benefits associated to this action would instead contrast with the minimization of consequences achieved by means of more integrated and long-term land use planning modifications, this second set of actions should be prioritized[452].

It is reasonable to conclude that similar considerations should be done in all cases in which the area of concern, like in the case-study, include more risk-sources and where a limited set of hazards reduction measures is possible. In real cases in fact only a limited set of decisions is

[452] This general conclusion brings us back to the discussion initiated when the model of van Breugel was introduced. How to assess the potential of disruption caused by major accidents and how to prioritize hazard reduction actions in the light of the qualitative nature of multi-dimensional criteria? In the context of this book, part of the reply was already given. As extensively discussed, in the light of the legislative, geographical, demographical and cultural differences characterizing European countries, a univocal methodological orientation for "measuring" such dimensions is not feasible. The indicators for, for example, "measuring" the potential of disruption of a given social and political systems due to the occurrence of major accidents are necessarily site-specific and cannot be defined *a priori*. In this respect, a recommendation to the European regulator has to be limited to the proposal of promoting a multi-dimensional understanding and characterization of risk, leaving to Member States and local decision-makers the task of defining their own and indicators for the assessment of relevant dimensions. Though this conclusion may appear as poorly ambitious, it may represent a realistic step forward towards a more integrated conceptualization of risk at European framework level while providing a valuable input for national policy-making processes.

available: comparing the two methodological orientations without having defined the outcomes deriving from the prioritization of different possible decisions may hence result ineffective.

In order to address similar reflections with regard to the obligation of information, I would refer to the results of the brief comparison developed in section 5.3. Here, two different "risk informative policies" in the context of MA risk were analyzed. The focus of the comparison was on the way risk-maps are used in two different countries for supporting, on the one hand, land use planning processes and, on the other hand, for communicating risk to third-parties. The first part can be therefore linked with the obligation of Operator of delivering information over MA risk; the second part can be generally linked to the obligation of Authorities of informing the public.

In the light of the interrelation between Operators and Authorities in both countries, wherein the provision of Safety Reports by the side of the former at the benefit of the latter is the first step of risk prevention evaluations, it may be concluded that the obligation of Operators of is equally accomplished. Furthermore, in both countries information over the risk of major accidents shall be provided to the public without a previous request from their side. The comparable accomplishment of this requirement emerges by the easy accessibility of risk prevention policies, legislations and risk assessment methods facilitated, in both countries, by means of their availability in regularly updated and easily accessible web-portals.

Nevertheless, the amount and quality of information appears to be different. As already argued, the availability on the Internet of multi risk-maps appears to reflect, in The Netherlands, the "right to know" of citizens in contraposition of the "need to know" which seems to be enforced in The United Kingdom, where information is distilled by Authorities and, in some cases, provided to third-parties only under specific request[453].

In order to address some ethical considerations with regard to this difference, it may be useful to argue on the amount of information which should be minimally communicated to the public and, as argued by Arcuri, on the matter of communication *vs*. information: the second in fact is not necessarily "coupled" with a better understanding of the matter of major accidents, especially when it involves the delivery of technical information of scarce clarity from the point of view of non-expert audiences[454]. In this regard, it might be useful to concentrate on one specific information of primary importance: the geographical dislocation and the nature of risks arising from Seveso establishments (as already defined, a *territorial information*). This information is publicly available in The Netherlands via the Internet, i.e. it is accessible on a permanent basis and without the public having required it; in the UK instead it is delivered, in most cases, by means of the publication of planning instruments and, therefore, on a sort of *ad hoc* basis. Furthermore, more types of risk are reported in the first case, and a clear visualization of their dislocation and nature is provided by means of an easy-reading legend. In the second case, this additional information does not compare among those elaborated by the UK Safety Authority.

Though a better understanding of these different informative systems would require a deeper analysis of the dynamics activated by Authorities in real cases of risk communication, it may be concluded that the "right to know" of the public is generally enforced more transparently in The Netherlands than in the United Kingdom. The public availability of multi risk-maps in fact doesn't restrict the access to information over Seveso establishments to people […] *likely to be in an area* ["Seveso areas" […][455], but extends it to the public as a whole. Furthermore, the elaboration of

[453] The distinction between "right to know" and "need to know" is provided among others by De Marchi *et al* (1996), *op. cit*. Whereas the former doesn't involve the selection of information to be delivered to the public by the side of deliverers, the latter is a process by means of which deliverers "distill" the information which is considered suitable and / or necessary for divulgation.
[454] A. Arcuri (2005), *op. cit.*
[455] Refer to the United Kingdom country-profile, paragraph 3.6.4

multi risk-maps by the side of provincial authorities and the existence of national d-base storing information over natural and technological risks on a national scale appears to be more in line with the necessity of maintaining a flow of information not only from Authorities to the public, but also from Authorities to the Commission and among Member States.

In conclusion, although it can be generally assumed that all European countries fulfill the (moral) obligation of information concerning major accidents risk, it is again demonstrated that to different contexts different interpretations of such obligation correspond. One of the last reflection to be addressed is therefore whether these differences can be justified on the basis of, beside the examined legislative and economical backgrounds, different cultural orientations. This particularly interesting reflection is reported in the following section.

5.5 Different approaches for different cultures?

The comparison of the various national implementations of Directive Seveso II and, in particular, of the methods and procedures implementing Art 12 showed interesting differences. Some of them were connected to the legislative backgrounds of the analyzed countries, such as the common law system of the United Kingdom and the precautionary principle enforced by the German constitution. Some others were connected to the specific demographical and geographical characteristics of Member States, which may have influenced the adoption of more or less conservative approaches to the matter of the prevention of the consequences of accidents in terms of land use planning restrictions in areas surrounding Seveso establishments. Finally, in the previous section, the different information policies developed in two of the analyzed countries (The Netherlands and the United Kingdom) were connected to the different institutional layouts, histories and cultural orientation of the countries.

This last aspect of European MA risk prevention policies is surely relevant. However so far it has been more an assumption than a consideration supported by evidence. Therefore, before coming to the final conclusions, it might be interesting to investigate how the cultural backgrounds of the five analyzed countries may have influenced the development of relevant MA risk prevention policies and supporting this assumption by means of a relevant analysis. Here, considerations can be only qualitative and derived from the available literature comparing the "cultural footprints" of European nations[456].

One of the main contributor to this interesting field of study is Geert Hofstede. In the last 25 years, this scholar has performed a number of analyses and case-studies aimed at highlighting the cultural aspects influencing, in particular, the different organizational patterns and the different relation individual *vs*. group which may be linked to different cultural national backgrounds[457].

[456] Few studies have analyzed the cultural factors influencing different orientations in risk prevention policy formulations. The work of S.H. Lesbirel and D. Shaw (2005, *op.cit*) reporting an international comparison of facility siting conflicts doesn't provide an insight of the cultural aspects which may justify different national orientations. The exponents of the psychometric perspective on risk have highlighted the different perception of risks by the side of the different groups of public, in so doing contributing to the understanding of the subjectivity and values influencing the "meanings" of risk (see Slovic 2002, *op. cit*.; Slovic *et al* 2004; Poortinga and Slovic 2003; see also the proceedings of the European project TRUSTNET, *op. cit*.). However, to my best knowledge these studies do not investigate the national cultural orientations which may partially explain different perceptions of risk by the side of the public in a rigorous way.

[457] In the analysis of Hofstede, cultural backgrounds correspond to national backgrounds. See G. Hofstede (1980), *Culture's Consequences: international differences in work-related values*, Sage Publications, Beverly Hills; G. Hofstede, *Cultures and Organizations: Software of the Mind*, Mc. Graw-Hill, London, 1991. Of particular relevance to this section is the article G. Hofstede (1994), Management Scientists are Human, Management Science, Vol. 40, No.1, 4-13

According to Hofstede, four independent dimensions can be used to characterize national cultures[458], namely

1. *power distance*, which expresses the degree of inequality among people which a population of a country considers as normal, i.e. from relatively equal (small power distance) to extremely unequal (large power distance);
2. *uncertainty avoidance*, which can be defined as the degree to which people in a country prefer structured over unstructured situations, the first being such situations clearly regulated by a set of (written or unwritten) rules providing the just behavioral guidance;
3. *individualism*, which is the degree to which people in a country prefer to act as individuals rather than members of groups. The opposite dimension of individualism is collectivism,
4. *masculinity* vs. *femininity*, which is the degree to which values such as assertiveness, performance, success and competition (traditionally associated to masculinity) prevail over values like the quality of life, maintaining warm personal relations, care for the weaker and solidarity (traditionally associated to femininity), and
5. *long-term orientation,* to which the value of perseverance and thrift are associated in opposition to the *short-term orientation*, to which values such as respecting tradition and fulfilling social obligation are associated[459].

A summary of the "cultural dimensions scores" obtained by Hofstede by means of the interview of employees of the same multinational in different countries is shown in Table 21:

Table 21 – the cultural dimensions score in a selected group of countries (after Hofstede 2003)

Orientation	Power distance	**Uncertainty avoidance**	Individualism	Masculinity	Long-term orientation
FRANCE	68	**86**	71	43	-
ITALY	50	**75**	76	70	-
GERMANY	35	**65**	67	66	31
NETHERLANDS	38	**53**	80	14	44
GREAT BRITAIN	35	**35**	89	66	25
JAPAN	54	92	46	95	80
BRAZIL	69	76	38	49	65
MEXICO	81	82	30	69	-
USA	40	46	91	62	29
WEST AFRICA	77	54	54	46	16

In the Table, the countries object of this comparative study are evidenced. By looking at the uncertainty avoidance index, expressing the degree to which people in a country prefer structured and clearly regulated situations in place of unstructured and de-regulated situations,

[458] G. Hofstede (1994), *op. cit*., at 7

[459] This fifth dimension was added to the original four after a study among students of 23 countries conducted using a questionnaires designed by Chinese scholars. This index is not applied to all the five countries object of this comparative study. For an overview of the state of development and application of the Hofstedian theories, refer to the website http://www.geert-hofstede.com/, online. Last visited: April 2008

some interesting remarks can be done. The countries with the highest score of uncertainty avoidance are, respectively, France (86) and Italy (75). The Netherlands and the Great Britain scored the lowest values, respectively 53 and 35. Germany is in an intermediate position with a score of 65. In Table 22, the Uncertainty Avoidance scores are combined with the MA risk prevention policies orientations (probabilistic *vs*. deterministic), the criteria used for (human and environmental) risk assessment and their status (legally binding *vs*. target criteria) of the five countries:

Table 22 – uncertainty avoidance scores and major accidents risk prevention policy orientations in the 5 analyzed countries

COUNTRY	Uncertainty avoidance score	MA risk prevention policy orientation	Criteria used for risk assessment	Status of the criteria
FRANCE	86	Traditionally deterministic, the method was recently reviewed and accounts probability classes as mitigating factor for establishing safety distances	Individual risk and "severity" levels deriving from the number of expected deaths	Legally binding
ITALY	75	Semi-quantitative: a deterministic assessment of accident scenarios and effects is followed by the estimation of probability classes. The latter are a mitigating factor for defining safety distances	Individual risk and (qualitatively) environmental risk have to be assessed	Legally binding
GERMANY	65	Traditionally deterministic , based on "worst" or "worst credible" scenarios	Individual risk	Legally binding
THE NETHERLANDS	53	Strictly quantitative: a full QRA is required in all cases establishments have to be installed and operated	Individual and societal risk	Individually binding for individual risk, target criteria for societal risk
GREAT BRITAIN	35	Based on the application of the ALARP principle, the evaluation of safety distances is risk-oriented in case of emissions and consequence-oriented in case of thermal radiation and explosions	Individual and societal risk	Target criteria based on the implementation of the ALARP principle

By looking at the Table, it is evident that to higher uncertainty avoidance scores more deterministic-oriented approaches follow. Additionally, legally binding criteria are prescribed in uncertainty-adverse legislative contexts. Notably, The Netherlands and The United Kingdom, which are the countries with the lowest scores, are also the only countries with an established tradition in risk-oriented MA prevention policies. Additionally, no legally binding criteria apply, in one case, for societal risk and, in the other case case, for none of the individual and societal risk criteria.

The last two countries are maybe the most meaningful for a validation of both the theories of Hofstede and the demonstration that MA risk prevention policies are, indeed, also "culturally

based". Notably, The Netherlands and the United Kingdom have scored similar values also for other dimensions, such as individualism (80 and 89 respectively) and power distance (38 and 35 respectively)[460]. The first dimension may be linked to the strong implementation, in both countries, of the ALARP/ALARA principle, which can be interpreted as a strong accent on the liability of Operators and Safety Authorities in enforcing all measures aimed at decreasing risks. The second dimension could be linked to the rather established cooperation among different authorities and, particularly in the case of The Netherlands, to the transparency and accessibility of information: in advanced democracies, characterized by a diffuse sense of equality among members of society in terms of power distribution, it is reasonable to expect an equally distributed access to information.

Also France and Italy have scored similar values in more than one dimension, and most notably in the uncertainty avoidance one. These two countries, beside applying a rather similar rationale to the matter of land use planning in areas at risk, are also the two countries in which compatibility matrixes combining vulnerability classes, effects levels and probability classes are adopted for providing national legally binding criteria for elaborating land use planning instruments. Their approaches are therefore less "judgmental" than the previous two, as they aim at providing a "safety standard" applicable to the whole national territory. A possible key-of-reading of this aspect of the two legislations is limiting individual responsibilities and preventing inconsistent evaluations across different regions and municipalities. Interestingly, the two countries scored the highest indexes of power distance.

Germany appears to be in an intermediate position between the previous two couples of countries. As extensively described in Chapter 4, Germany is the country in which a precautionary approach to safety and environmental related issues is stated in the primary legislative source represented by the Federal Constitution. It is therefore the country with the longest and more "resistant" tradition in deterministic-oriented MA risk prevention policies, prescribing legally binding criteria. It could have therefore been expected that the uncertainty avoidance score would have been higher than those of France and Italy. A possible explanation of the different outcome derived from the combination of the analysis of Hofstede and the German MA risk prevention policy in comparison to the other four may be linked to the legislative autonomy of the 16 states of the Federation, responsible for implementing the principles of the constitution and the related legislative framework with a high degree of autonomy. Though deterministic in principle and legally binding in practice, German MA risk prevention policy as presented in this book has to be interpreted as the general framework to which different national implementations refer. Considering the dimension and the variety of states composing the federation, it is presumable that different uncertainty avoidance scores would be found in the various states and that the reported value corresponds to an average value.

In conclusion, the combination of the uncertainty avoidance scores with the main elements characterizing MA risk prevention policies of the analyzed countries is meaningful both for a validation of the theories of Hofstede and the demonstration that MA risk prevention policies are, indeed, also "culturally based". This evident influence of cultural backgrounds to policy-making in

[460] Individualism is defined by Hofstede as " […] *the degree to which individuals are integrated into groups. On the individualist side we find societies in which the ties between individuals are loose: everyone is expected to look after him/herself* (…). *On the collectivist side, we find societies in which people from birth onwards are integrated into strong, cohesive in-groups, often extended families* (…)". Power distance is defined as "[…] *the extent to which the less powerful members of organizations and institutions (like the family) accept and expect that power is distributed unequally. This represents inequality (more versus less), but defined from below, not from above. It suggests that a society's level of inequality is endorsed by the followers as much as by the leaders* […]", online. Available at http://www.geert-hofstede.com/ . Last visited: January 2009.

general and risk prevention policies in particular should be accounted by the European regulator as one of the fundamental "limits" of a joint European approach to the matter of MA risk prevention: whereas the common problematic aspects related to the governance of MA risk from the side of the territory may be considered the horizons of a more comprehensive European regulation, the national cultural specificities relevant to the political, methodological and procedural aspects of implementations should be regarded as its limits.

In this regard, it should be noted that the trend revealed by the analysis of the five MA risk prevention policies which were considered in the course of this Chapter is for the adoption of risk-oriented approaches. France, which has historically adopted a consequence-based approach to MA risk prevention, has entirely reviewed her policy after the accident of Toulouse; Italy, where the "youngest" legislation addressing the matter of land use planning in MA risky areas was issued in 2001, has opted for a semi-quantitative approach that doesn't exclude the consideration of probability classes as mitigating factor for assessing safety distances.

This trend might be seen as a consequence of a number of factors. A primary and surely relevant factor is the number of existing situations which were in place before the emanation of the Seveso II Directive, which were (and are) a sure disincentive for the adoption of consequence-based approaches. A second factor might be the example provided to "youngest regulations" by well established MA risk prevention policies, like the British and the Dutch one. The relevant approaches and methodologies are well documented in literature and easily accessible by means of transparent informative tools such as the Internet and the publications issued by governmental agencies. A third factor could be the general acknowledgment that, equally to natural risks such as floods and hydro-geological events, the risk of major accident has an inherent probabilistic nature. The Communication of Toulouse is, in this regard, a clear sign of such acknowledgement at European level.

A point of discussion here could be whether this "risk-oriented trend" should be reflected at European level in future regulations. Here my recommendation would opt for the avoidance of such choice by the side of the European regulator. My arguments are based, in particular, on two aspects: the demonstrated potential frictions between the different principles informed by the various national constitutions and/or relative legislative backgrounds (with the two opposite extremes represented by the United Kingdom and Germany) and the undeniable cultural basis on which such differences are grounded. These two elements should discourage the provision of specific methodological orientations to the matter of risk prevention in general, and the risk of major accidents in particular, at European level. This conclusion will be further discussed in the final Chapter.

5.6 Concluding remarks

In this Chapter, selected European major accidents risk prevention policies were compared. The comparison focused on some general differences, such as national legislative backgrounds and relevant socio-demographical contexts. More in details, a case-study investigated the methodological differences among different land use planning practices in four countries (France, the United Kingdom, The Netherlands and Italy) and different MA risk informative systems (The Netherlands and the United Kingdom). Two final discussions over the ethical aspects of the relevant methodological approaches and the influence that different cultural orientations may have exerted on their definition were finally developed.

Leaving the general conclusions at Chapter 6, the results of the previous analyses can be collected in three different "problematic issues", namely

- The methodological,

- The ethical-political, and
- The cultural issue.

The first issue was explored in detail by means of the case-study. Here, the comparability of four different methodological approaches to the matter of land use planning in at-risk area was made possible by the mono-dimensionality of the concept of risk enforced in relevant legislations. In all analyzed countries in fact, *risk* is essentially characterized by the probability of death of and / or physical effects on human exposed to major accidents. As retraced in many of the analyzed institutional documents and guidelines, this characterization of risk in legislations serves to provide clear criteria and "measurable" indicators to decision-makers when assessing the consequences of accidents. This characterization of risk facilitates the modeling of accidents in terms of their consequences on humans, the definition of a threshold for their acceptability, and the provision of criteria to Operators and Authorities for performing risk evaluations. Implicitly, this characterization of risk facilitates the definition of a national safety standard while providing a "quantifiable" criterion for setting acceptability levels.

Although the legal status of such criterion is not necessarily translated into legally-binding thresholds of acceptability (as in the United Kingdom for individual risk and in The Netherlands for societal risk), the rationale behind its enforcement is providing an indicator suitable to guide, among other evaluations, land use planning evaluations. The characterization of risk in terms of (probability of) effects on humans is *de facto* a geographical visualization of the areas of impacts of major accidents, within which land use planning evaluations have to be performed accordingly to the scope of the Seveso Directives. In the light of the inherent uncertainty characterizing such evaluations and what was called the *unpredictability* of the development of accidental scenarios, it derives that the [definition of] *appropriate distances from establishments* required by Art 12 is a process characterized by inherent uncertainty, which was also defined as *imperfect knowledge*.

Despite the common mono-dimensionality of the concept of risk enforced in the analyzed legislations, the result of its adoption within land use planning evaluations resulted to be remarkably different. In Germany and, until recently, in France, such evaluations are based on the only consideration of the effects on humans, without considering the probability of accidents as an explicit decisional criterion[461]. In the United Kingdom, The Netherlands and Italy the calculation and consideration of probabilities is an explicit decisional instrument. However, even here some differences have been retraced.

The first methodological orientation leads to more conservative characterizations of risk and, in practice, to a "wider" geographical representation of the areas of impacts within which restricting land uses. However, it was demonstrated that such approach does not necessarily lead to prioritize hazard reduction actions resulting in the increased safety of the areas of concern. By means of the comparison of the hazard reduction actions which would be given priority by applying the French and the Dutch methods in the Piombino area, it has been qualitatively demonstrated that the structural and long-term land use modifications promoted in the second case would decrease the vulnerability of the area in a more integrated way in comparison to the "punctual" effect deriving from the elimination of a fixed risk-source promoted by the first method. The overall assumption of this conclusion is that in front of a limited set of hazards reductions actions, and hence possible decisions, the prioritization of the elimination of low probability / high consequences risk source may happen at the expanses of an integral reduction of the intrinsic and extrinsic vulnerability of the area.

[461] I specified *explicitly* to underline that even if probabilistic considerations may be not explicitly allowed in some legislations, they may be performed *implicitly* during risk assessment processes. Refer to section 6.x of the Conclusions.

This result, though derived by means of some deliberate and qualitative assumptions, it is among the most important of the case-study as it led me to question the supposed more "precautionary character" of deterministic methods. In theory, the *non* consideration of probabilities as decisional criterion in those cases in which decision-makers need to prioritize hazard reductions actions according, for example, to limited economical resources (which are presumably the majority of real cases) may result in a less effective minimization of the expected consequences of accidents in comparison to the set of decisions deriving from probabilistic considerations. As it will be discussed in the final Conclusions, a theoretical discussion over the desirability of adoption of one of the two methods should be hence performed by looking at the practical repercussions of each of them in a real-case scenario.

Two other points of discussion emerged from the case-study. The first is the appropriateness of considering societal risk next to individual risk, while the second is the consideration of the risk arising from the transport of dangerous substances together with the risk arising from fixed installations. With respect to the first point, the case-study demonstrated how the consideration of societal risk as defined in The Netherlands may represent a useful decisional instrument in the hands of decision-makers, as it provides additional information on the risk run by people transiting in areas where more establishments are present. With respect to the second point, the case-study demonstrated how the consideration of the risk due to the transport of dangerous substances may result in the prioritization of hazard reduction actions with a long-term effect in terms of the decrease of vulnerability of Seveso areas. The inauguration of a separate route for the transport of dangerous substances in Piombino, which would be given priority by means of the application of the Dutch method, would result in a significant decrease of concentration of people and goods transiting in the area and, in so doing, in a decrease of exposure to the consequences of accidents. It may be argued that the separation of routes for the transport of dangerous substances and normal traffic would lead, *de facto*, also to a concrete decrease of the risk of other forms of accidents, as it minimizes the risk of crashes between industrial and ordinary transportation means.

The risk arising from Seveso installations and from the transportation of "Seveso" substances are considered separately in the European regulation as well as in the majority of national legislations. Their integration in a comprehensive supra-national regulation seems hence a recommendable horizon of future policy developments. This point will be among those discussed in the concluding Chapter.

The last point of discussion which may be derived from the case-study is the issue of the risk to the environment. This evaluation is explicitly required in The Netherlands as an integral part of the operating permit procedure and, consequently, was not applicable to the case-study: in a real case, the compatibility of the various Seveso establishments of the area of Piombino with the surrounding environment would have been, theoretically, implicit to their location. Differently, this evaluation is required as part of the requirements of the Italian Decree regulating land use planning in Seveso areas[462]. In the United Kingdom, relevant evaluations are instead performed separately.

The matter of defining appropriate distances between Seveso establishments and environmental targets is rather complex as, differently than for humans, it is more difficult to define quantifiable criteria applicable to the whole set of environmental goods. Furthermore, applying the rationale of the risk to people (which is essentially the probability of death), only environmental losses should be considered by legislations. As demonstrated by the case-histories reported in Chapter 3, environmental damages are instead represented by long-term and continuous effects rather than immediate losses. The former can be an important vehicle also for the persistence of effects on humans. It is important to notice that preventing the effects of accidents on

[462] Refer to the Italian country-profile at Chapter 4.

the environment includes, in this perspective, also the prevention of the long-term effects on humans: their consideration as separate systems may hence represent an important limit of risk assessment processes.

Coming back to the matter of defining suitable criteria for assessing environmental risk, the site-specificity and the difficultly assessable effects on the environment deriving from the exposure to accidents represent a clear limit for effective policy- and decision- making processes. On the other hand, this complexity may be seen as an opportunity, as it may open to the introduction of more qualitative and multi-dimensional considerations next to the ordinary quantitative considerations resulting from legislations. The Italian legislation, providing a criterion for assessing the compatibility of the environment with respect to MA risk which considers the time necessary to re-establish the environmental situation in place before the occurrence of accidents, may be seen in this perspective. Though this criterion demonstrated to be of difficult utilization and presents some clear limits from the point of view of its applicability, it represents the opportunity to reflect on one fundamental issue: the matter of striving for a conceptualization of environmental vulnerability which considers the long-term effects of accidents on both the environment and humans.

The second part of the Chapter addressed the comparison of two different MA risk informative systems, namely the Dutch and the United Kingdom systems. Here, the "right to know" embodied by the Dutch policy in comparison to the "need to know" embodied in the United Kingdom were compared by means of a focus on the use of risk-maps for supporting land use planning processes. Although in both legislative contexts the obligation of information deriving from the scope of the Seveso Directives seems to be accomplished, different forms and type of information seem to be delivered throughout European countries. Here, it may be interesting reflecting on the horizon of an harmonized MA risk informative system at European scale.

However, as demonstrated in the final part of the Chapter, this horizon may be obscured by the limits represented by national cultural differences. Among the factors influencing the adoption of different MA risk prevention policies in Europe, the cultural factor revealed to be an important one next to the heterogeneity of the demographical, economical and territorial features influencing national risk policy-formulation processes. In this perspective, the matter of defining an equally applicable method to resolve the matter of land use planning in at-risk areas becomes a false problem. The horizon of the research to be conducted in this field is rather to provide decision-makers, and planners in particular, with the interpretational and operational instruments which are equally necessary to arrive to comprehensive and sound decisions. This will be discussed in the final conclusions.

CHAPTER 6

Conclusions: learning by this research

So this is the end, but also the beginning
of a history I'd like to keep talking with you about
to see together whether, after all, there's a sense in it

T. and F. Terzani, "The end is my beginning", 2006

At the end of this journey in the variegate universe of European major accidents risk prevention policies, some conclusions regarding the horizons of the common European regulation in general, and of territorial risk management in particular, are derived. The purpose of this final Chapter is collecting the conclusions which were already presented along the course of this book and elaborating them further. In consideration of the cross-sector audience the book is written for, some sections will result more interesting for policy makers and scholars of ethics; some others will provide more valuable inputs to spatial planners. Coherently with the assumption that […] *the notion of risk can be properly analyzed only from an interdisciplinary perspective* […][463], and that this investigation has tried to adopt different points of view during its development, these conclusions are rather general. Indications for further research, which may focus on the most problematic challenges associated to the matter of preventing the consequences of risk through what we called *sensitive* land use planning policies, are therefore proposed.

6.1 Research questions replied in a nutshell

a) Which are the characterizing elements of the different national implementations of Art 12?

As any other European requirement Art 12 finds application in different territorial, demographical and legislative contexts. The characterizing elements of different national implementations of the article are hence to be retraced in the different political, spatial and demographical characteristics of Member States as well as in the different institutional lay-outs. Different land use planning methods in Seveso areas result from these different backgrounds; they mirror them rather than representing deliberate methodological orientations. In general, two methodological orientations can be individualized, whose rationale is either deterministic or probabilistic. Whereas in the first case decisions are based on the only consideration of the expected consequences of accidents, in the second their probability is an explicit decisional

[463] A. Arcuri (2005), *op. cit*., at 237.

element of land use planning evaluations. However, consequence-based methods may be based on the implicit consideration of the probability of accident scenarios.

In all analyzed countries consequences are described as mono-dimensional: the criterion adopted for performing land use planning evaluations is the (risk of) fatality of humans.. Whereas in some countries the risk is evaluated as individual or stationary risk, in some other the criterion of societal risk comes into play. Legally binding and target criteria are differently prescribed by national legislations, also in consideration of the type of risk index (individual vs. societal) considered. In The Netherlands for example the risk of accidents includes the risk from transportation of dangerous substances beside the risk arising from fixed installations. Finally, whereas in some countries an introduction of criteria for evaluating environmental risk was proposed in the corpus of laws implementing Art 12, in some others the matter of environmental risk is regulated through separate laws and procedures.

In conclusion, the characterizing elements of national implementation of Art 12 can be grouped in three categories:

i) The legislative background (common vs. roman law);
ii) The methodological orientation (probabilistic vs. deterministic), and
iii) The demographical and socio-cultural background (like high population density and uncertainty-avoidant vs. uncertainty- "oriented" cultures).

b) What determined the development of different methods for land use planning in Seveso areas in the examined national practices?

As explained above, different demographical characteristics and legislative backgrounds appeared to be determinant factors for the development of different methods. High population density and land scarcity appear to influence the development of quantitative probabilistic methods; roman vs. common law systems appeared to influence the adoption of legally binding vs. target-risk criteria. The latter are relying on the implementation of principles as ALARP/ALARA for the safety management of establishments and for performing risk assessment and land use planning evaluations.

In conclusion, different methods for land use planning in Seveso areas reflect the different "hard" and "soft" variables characterizing the examined national backgrounds. In this respect, a methodological harmonization at European level appears not only not feasible, but also scarcely desirable.

c) Are different national methods leading to different levels of prevention?

Whereas it can be generally assumed that all analyzed national methods comply with the primary and residual obligations deriving from the scope and requirements of the Seveso Directives consistently, different methods lead to perform different evaluations because of the consideration of different decisional elements. In particular, whereas deterministic methods revealed to be sensitive to dangerous substances inventories, probabilistic approaches revealed to be more oriented to vulnerability reduction. Whereas the former method may more easily result in the reduction or dislocation of hazardous substances, the latter method may more easily result in an increase of resilience of the surrounding environment. These different outcomes depend also on the risk criteria (individual vs. societal) utilized for assessing risks, and on the set of reference scenarios selected for land use planning purposes. However, in the hypothetical case of the same reference scenario (for example the worst-case scenario of a low probability / high consequences accident) and the availability of a limited set of hazard reductions measures, the two methods would prioritize hazard reduction actions according to the described differences. A deterministic evaluation would prioritize the decrease of hazardous substances inventory or the removal of the

facility, whereas a probabilistic evaluation would prioritize the further decrease of probability of the event and the increase of resilience of the surrounding context.

It is rather difficult to assess the overall reduction of risk and minimization of consequences deriving from the two different methods *quantitatively*. However, it is possible to compare the two outcomes *qualitatively*. Keeping in mind the assumptions of the above mentioned example, a "punctual" intervention focusing on the dislocation of the risk-source may result less effective than an "integral" spatial intervention focusing on the overall increase of resilience of the surrounding context. Whereas the first measure doesn't decrease the vulnerability of the territory in the long-term, the second measure leads to spatial structural modifications, in so doing strengthening the resilience of the area with regard, for example, to future possible risk-sources. Furthermore, whereas deterministic methods in land use planning may be interpreted by Operators as an incentive to decrease the hazardous substances inventory right below the amount whose areas of impacts reach vulnerable targets, probabilistic methods in land use planning may be interpreted by Operators as an incentive to invest in the safety performance of establishments, decreasing in so doing the probability of events at source and contributing to the improvement of the relevant technology.

In conclusion, the two methods apply a different rationale, but they also reflect a different *aim* of regulators, who depending on their context have probably departed from different assumptions for formulating their land use planning policies in the context of industrial risk. Rather than the comparison of the different outcomes deriving from the two different methods, it may be therefore concluded that it is the underlying *scope* of land use planning evaluations that have guided the preference of one of the two orientations in the examined countries.

d) How are political views and cultural orientations influencing the preference of different approaches?

It has been demonstrated that national legislative contexts and cultural orientations may influence the adoption of the two methods together with the design of the procedures implementing them. Countries like Germany, wherein the precautionary principle is part of the Federal Constitution, opted for a *non explicit* consideration of probabilities when addressing the matter of land use planning in Seveso areas. However, this consideration may be done implicitly when selecting the reference scenarios to be used for planning purposes, for example by selecting the " most *credible*" of "representative" scenarios. Here, implicit probabilistic considerations underlie land use planning evaluations. However, the explicit political and methodological orientation of the Country remains deterministic.

By their side, cultural orientations demonstrated to influence the adoption of structured vs. non-structured decisional processes as well as probabilistic vs. deterministic methods. The combination of the uncertainty-avoidance cultural index proposed by Hofstede with the characterizing elements of the analyzed national implementations of Art 12 demonstrated that the higher the uncertainty-avoidance cultural index, the more structured the decisional processes and the more deterministically oriented the land use planning methods. A meaningful example is offered by the United Kingdom. Here, to a very low uncertainty-avoidance cultural index a judgmental approach to the matter of risk prevention in land use planning is associated. The implementation of the ALARP principle to the safety management of establishments as well as to land use planning evaluations is not coupled with the requirement of complying to legally binding criteria. Legislation provides in fact target-criteria, and leaves margin of directionality to both operators, safety authorities and planners. The fact that the country is based on a common law system and relies on a case-based legislation may explain this orientation of the UK regulator.

In conclusion, national both political and cultural orientations come to light through the analysis of the different land use planning policies implementing Art 12 developed in the examined countries. The same orientations would be probably retraced by analyzing other safety-related and environmental-related regulations. These distinctive aspects are, on the one hand, reflected in the high level of generality of the requirements of the Seveso Directives, and of Art 12 in particular; on the other hand, they represent the "limits" for the development of the Directives towards a European harmonized methodological approach.

This remark anticipates the final conclusions, which regard the "limits and horizon" of the common European regulation on industrial risk in land use planning.

6.2 Limits of a mono-dimensional characterization of major accidents risk in the European regulatory framework

In Chapter 1, several definitions of risk as reported in European technical and governmental glossaries were analyzed. After the accidents case-histories reported in Chapter 2 and the consideration of whether the "essence of risk" equation would have captured the multidimensionality of the consequences of the events that have more than any other influenced the developments of the Seveso Directives, the derived conclusion was the necessity of approaching the matter of risk prevention from a multi-dimensional perspective. A definition of risk suitable to incentive the evaluation of what could be called the *extended* consequences of accidents was therefore proposed. This definition reads as follows:

> *Risk represents the possibility of losses or disruption of lives, goods and options humans value.*

The definition was further explained specifying that such losses or disruptions regard a given human-environmental system, refer to one or more hazardous events caused by one or more interconnected elements of the system, and may be irreversible. These consequences are determined by the interaction of four elements: the nature and likelihood of the hazardous events and the intrinsic and extrinsic vulnerabilities of the system.

At the end of this book I'd like to reflect on this definition more in depth. First of all, rather than a definition I would call it a *conceptualization*. Definitions are *per se* static and univocal; conceptualizations are dynamic and multifaceted. The former should therefore complement rather than substitute the latter, whose nature is explanatory rather than distinctive.

The explanation of this conceptualization was already given. The disruption or losses of lives, goods and options human value embrace the whole set of dimensions (or sub-systems) reported in the model of van Breugel [464]; g*oods* and *options* may represent both the environmental, social and ethical dimensions valued by society.

The *given human-environmental system* is the part of the definition which can be more easily misinterpreted. As explained in Chapter 1, the man-environment-technology (MET) system is a complex system, within which the three sub-systems are interconnected and interdependent (Ale 2007). When approaching the risk associated to site-specific risk sources, such as dangerous chemical installations, it is of primary importance focusing on the *given* interconnections and interdependency of these elements: only by looking at the *specific* potential losses and disruptions their prevention by means of opportune hazards reduction measures becomes concretely possible[465].

[464] K. van Breugel (2005), *op. cit.*

[465] A natural question here is how to "measure" the potential of disruption in the light of the qualitative nature of these dimensions. I believe that neither the academia neither policy are ready to provide

This clarification serves to reaffirm the relevance of the *hic et nunc* dimensions of major accidents and the importance of investigating the conditions determining the specific developments of the consequences of these events in a given *space* (in the broad connotation of territorial, socio-political and cultural space) and in a given *time* (in the broad connotation of the repercussions of an "instantaneous" event to the long-term consequences).

The matter of the inherent uncertainty underlying this multidimensional evaluation was discussed before (Chapter 2). In the following, it was further discussed how in the case of low probability / high consequences events the *irreducibility* of this uncertainty can be only dealt with by adopting a precautionary approach to decisions, evaluating in so doing the potential consequences of *inaction* rather than focusing on the set of *actions* which can be grounded on limited scientific evidence. Far from being a non-scientific optic, the adoption of a precautionary approach in this context is consistent with a simple observation: beyond methods and across cultures, in front of the potential of the irreversible losses and disruptions caused by accidents decisions respond to an ethical rather than to a methodological mandate. Different methods may arm the hands of decision-makers with different and sometimes sophisticated decisional elements; however, these arms may be insufficient to combat the residual uncertainty inherent to any decision relevant to the future. What can be done in the present is extending the characterization of consequences to their multidimensionality, and creating the "reflecting discourse" by means of which the relevant representations and interpretations of different parties are accounted and reflected in the final decisions.

At this point, the definition of risk as given in the text of the Seveso Directives is reported:

> *Risk (shall) mean the likelihood of a specific effect occurring within a specified period or in specified circumstances*

Being the aim of the Seveso Directives the prevention of accidents involving dangerous substances and the minimization of their consequences to humans and the environment, the given definition of risk is translated in national implementations as the risk of health effects; the generally adopted risk criterion is hence the (probability of) deaths of humans.

As extensively discussed in the course of the book, this characterization of risk is limited from a policy perspective and insufficient from a decisional one. It is politically limited because it creates the premises for an operational approach to risk assessment as an equation to be resolved; it is "decisionally" limited because even though this equation can be theoretically resolved, the outcome is insufficient for determining the proper decisions. It is hence up to policy to create a virtuous mechanism which may induce decision makers to overcome the limits posed by this insufficiency.

A proposal in this direction is adopting the given conceptualization of risk and a corollary of relevant indications at European framework level. Suitable to prime *extended* risk evaluations, this conceptualization of risk wishes to lead regulators and decision makers to embrace an interdisciplinary and multi-faced understanding of industrial risk. This approach to risk should become the bottom line of relevant evaluations and the guidance for any controversial decision, and not remaining the additional policy option solely urged by the academia. As demonstrated in Chapter 1, striving for the univocal definition of concepts such as risk and uncertainty is not the

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straightforward and equally valid answers to this question. What the findings of this investigation are ready to defend is that the ambition of "measuring the immeasurable" indicates, however, the wrong research trajectory. Differently, insisting on exploring how policy and decisional processes may become more sensitive to how these dimensions are valued by members of society may be a fruitful and practically viable one.

fruitful neither theoretical nor policy direction; promoting their multidisciplinary, intra- and cross-cultural understanding by the side of policy-makers, decision-makers and the public surely is.

The European safety regulation and the Seveso Directives in particular may offer an opportunity in this regard. As explained in Chapter 3, the aim and scope of the European regulation in this domain respond to a supra-national and implicitly cross-cultural ethical mandate. This mandate may be better indicated by a conceptualization of industrial risk and a characterization of its consequences that overcomes the limits of the currently implicitly adopted "essence of risk" equation. Far from saying that the conceptualization of risk proposed in these Conclusions, and the corollary of provided indications, will accomplish to this mandate effectively, it is surely defendable that they may prime a virtuous mechanism from which more sound and sensitive risk evaluations could derive. As "[…] *theory becomes interdisciplinary under the pressure of policy-making* […][466], policy-making may become interdisciplinary under the pressure of crucial decisions.

6.3 Safety as a spatial benefit: towards a new formulation of the matter of land use planning in at-risk areas

In Chapter 3, the analysis of the ethical theories which may be applied to the understanding and formulation of major accidents risk prevention policies in the context of land use planning was developed. The most interesting outcomes of the analysis regard the resolution of two ethical dilemmas associated to the presence of dangerous establishments in the European territory, namely:

a. The conflict between the first principle of Rawls, regarding the common right to life of humans, and the risk distribution inequality;
b. The *clash of absolute principles* between the freedoms of risk-posers and risk-runners.

The first dilemma was resolved by referring to the informed-consent theory, through which the inequality of the risk distribution (justified by the common benefits associated to the presence of dangerous establishments) is resolved by means of the free acceptance of risks by the side of the exposed members of society[467]. As already argued, in compliance with the primary right of freedom, this acceptance has to be based on the awareness of the likelihood and consequences of such risks and the inherent uncertainty characterizing their assessment. Whereas *awareness* passes through *knowledge*, the role of information becomes therefore crucial.

Nevertheless, an informed consent approach to facility siting doesn't resolve the status of inequality; it only legitimates it. The second dilemma refers to this matter. In the analysis of Petterson and Hansson[468], the existence of dangerous establishments and the exposure of members of society to the relevant risks is seen as a *clash of absolute principles*. On the one side there is the pursuit of collective benefits, and on the other side the right of individuals of not being exposed to involuntary risks. This dilemma was resolved by establishing the conditions under which risk-posers can operate their activities and without which the risk-runners have the right to oppose against them. These conditions were established through a set of *residual moral obligations*, which are the obligations of informing, improving and compensating respectively[469].

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[466] A. Arcuri (2005), *op. cit*., at 239

[467] It is important to remind the premise of this reasoning, which is that the "deontological decision" of establishing a level of acceptable risk to be equally guaranteed to society is preventively enforced by legislations. The acceptance of *risk* shall not be confused with the acceptance of *consequences*; the risk of concern in this statement is therefore the *residual risk*.

[468] Petterson and Hanssen (2004), *op. cit.*

[469] I want to remind how the fourht residual obligation of *searching for knowledge*, which is explicitly considered in the work of the two Authors, was here considered implicit to the obligation of improving.

Having resolved these two fundamental dilemmas, an ethical framework referring to the mandate and scope of the Directive Seveso II was proposed. In this framework, the primary obligation resulting from the aim of the Directive was defined together with the residual obligations which have to be accomplished by the two parties involved (namely, Operators and Safety Authorities) to legitimate their "risky business" in front of society, regarded as the collective third-party.

Is this framework somehow reflected in the current European major accidents risk prevention regulation?

As argued in Chapter 3, the evolution of the Seveso Directives is marked by the increased role given to intra-state and inter-states flow of *information*. In this regard, it was concluded that the relevant moral obligation is already fulfilled by the regulation. For what regard the obligation of improvement, this is less explicitly but yet implicitly reflected in the Directives. Art 9 (5) of the second Seveso Directive reads […] *The safety report shall be periodically reviewed and where necessary updated* (…) *where justified by new facts or to take account of new technical knowledge about safety matters* (…) *and of developments in knowledge concerning the assessment of hazards* […][470]. It may be hence generally concluded that the Seveso Directives indicate the obligation of improvement to Operators and, although more vaguely, to the Authorities responsible for land use planning.

When it comes to the matter of compensation the discussion is far more complex. The text of the Directive doesn't indicate the obligation of compensation neither by the side of Operators nor by the side of Authorities. This may be explained in various ways. The first is that the matter of compensation comes into play in front of the siting of new facilities, modifications of existing ones or modifications of the land use planning in their surroundings. Furthermore although implicitly, it comes into play in all cases of existing situations. In simple words, the matter of compensation comes into play in the domain of Art 12. However, as explained the article states an objective, and not the instruments by means of which reaching it. Furthermore, this objective is related to the appropriate siting of Seveso establishments, and not to the resolution of the acquired "risk inequality" of citizens living in their surroundings.

In the light of these consideration, an hypothetical introduction of the moral obligation of compensation among the requirements of the Seveso Directives appears to fall under national and not European regulatory competences. Member States have in fact the legislative power to establish higher standards and broader scopes than the minimal standards and scopes established at European level. However, a question arises: shall the moral obligation of compensation, together with the obligations of information and improvement, be explicitly addressed by the Seveso Directives?

This question is of rather difficult reply. According to the subsidiarity principle, the "[…] *Community shall take action if and in so far as the objectives of the proposed action cannot be sufficiently achieved by the Member States and can therefore, by reason of the scale or effects of the proposed action, be better achieved by the Community* […]"[471]. According to the subsidiarity principle, the "domain" of European regulation is therefore the one in which individuals or Member States would not achieve the objectives of actions sufficiently (the *sufficiency* criterion) and when the action brings added value over and above what could be achieved by individual or Member State governments action alone (the *benefit* criterion). As discussed in Chapter 3, the aim, scope and requirements of the Seveso Directives appear to be consistent with the subsidiarity mandate of the European regulation; the lack of a common regulation in this domain may

[470] Refer to the text of the Directive referenced in the Introduction, Art 9 (5)

[471] See Art 5(2) of the *Consolidated Versions of the Treaty on European Union and of the Treaty Establishing the European Community*, OJ 321 E/1, 29.12.2006

theoretically lead to the development of more or less Seveso-favorable legislative contexts, and to the lack of consistency between the safety regulations of those establishments whose accidents are suitable to cause trans-frontier effects.

However, whereas the scope and requirements of the Seveso Directives can only be achieved through a consistent regulation of the obligations of *intra-* and *inter*-state information and improvement, it is questionable whether the objective of "safety equality" can be only achieved by means of a communitarian rather than national action. This would mean affirming that the objective of safety equality, achievable through the free acceptance of residual risk by the side of communities and through their compensation, is an objective that the Union can achieve better than Member States alone.

From a theoretical perspective the discussion becomes even more complex. In Chapter 3 the discussion of the matter of compensation was developed by recalling the work of Moroni on the "ethics of territory"[472]. The admirable effort of the Italian scholar is investigating the "primary spatial benefits" which have to be guaranteed to society in the Rawlsian perspective of social equality; *safety* compares among them. Starting from this reasoning I derived a conceptualization of *safety* as *spatial benefit* that, beside being particularly fashionable in the context of this book, is fully consistent with the ethical analysis developed in the same Chapter. Starting from the assumption that site-specific risk sources create an *unequal distribution* of the *spatial benefit of safety*, a compensation by means *additional spatial benefits* should take place.

In ethical terms this is an important conclusion[473]. However, this conclusion can be easily opposed by moving from different ethical assumptions. Opponents of the so-called market approach to facility siting (Linneroth-Bayer 2005) claim that the transaction of compensative measures from Operators and / or Authorities to communities regards the health of individuals and eventually their children, and therefore a primary right which cannot be "priced" by the market. The distortion of the market approach indeed is that, in principle, individuals may decide to run a higher risk than acceptable because of the monetary compensation available. By contrast, communities may reject the proposal of installing a dangerous facility because of the feeling of being basically "corrupted" by means of monetary compensation for the acceptance of a risk, *per se* and because of the emphasis put on compensation, unacceptable.

In order to overcome this problem, in the context of my analysis the risk of concern is always the *residual* risk, corresponding to or under a legally established acceptability level. Secondarily, the compensation of concern is a *spatial* and not monetary compensation. The latter represents the means of creation of the former, but is not a compensative measure *per se*. Rather than by means of a monetary transaction, the residual obligation of compensation should be accomplished by means of a *spatial compensation* to the communities who have accepted to be exposed to residual risks. This spatial compensation may be represented, for example, by giving access to green areas which would be difficulty accessible from other urbanized districts of the municipality, or by constructing educational and healthcare facilities which are less easily reachable by other sides of the town or city[474]. In general, a process of spatial compensation should

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[472] S. Moroni (1997), *op. cit.*

[473] Although derived from a variety of different assumptions, this conclusion is not new and rather established in literature. See in particular Kunreither *et al* 1993, reported by Kasperson 2005 (*op .cit*) and Linneroth-Bayer (2005), "Fair strategies for siting hazardous waste facilities", in S.H. Lesbirel and D. Shaw (eds), *op. cit*.

[474] Linnerooth-Bayer describes experiences of deliberative facility siting processes in which compensative packages offered to candidate communities included green areas, road maintenance and additional social facilities. The Author analyzes both the successful and unsuccessful among them. In her conclusions, the Author argues how failures do not necessarily relate to the stage and amount of compensation, but rather to

be meant to individualize the additional spatial benefits which are suitable to balance the risk inequality of an area with respect to other areas of the village, municipality or region of concern.

Whereas this is a theoretical resolution of the matter of risk inequality in society, experience demonstrates how its application is rather difficult in practice. The utilitarian orientation underlying the market-approach to facility siting in fact fails in front of the specific features characterizing the communities involved in siting processes. "Communities" is indeed a rather abstract concept, that doesn't capture the cultural and political diversities underlying different groups of citizens, and their forms of interaction with and perception of governmental processes. Exponents of the egalitarian approach to facility siting demonstrated how to a theoretically achieved social equality, residual feelings of inequality and risk imposition may survive among individuals (Thompson 1996, reported by Linnerooth-Bayer 2005). Furthermore, the market-approach demonstrated to be more effective in already socially disadvantaged contexts, wherein citizens are more willing to accept compensation than in wealthy areas (Bullard 1993, *ibid*). Rather than resolving inequality the market-approach seems hence to emphasize it.

To this remark I would add that whereas the residual risk of concern in certain areas may be related to dangerous Seveso establishments, in other areas it may be related to waste disposal facilities or aircrafts traffics; in principle, any area or district of a municipality may be more or less exposed to certain kinds of risk, and therefore every single community may claim the right of being compensated for their relevant acceptance. Finally, European population is more and more multi-cultural, and different cultural-specific or multi-cultural groups may live in different areas of the same town and city. The increasing local dimension of multi-culturalism that seems to characterize European society does hence weaken the possibility of addressing the matter of risk as a sort of "mono-cultural" matter, as done in Chapter 5.

In conclusion, the resolution of the matter of risk inequality achievable through the voluntary acceptance of residual risks by the side of involved communities and through their spatial compensation represents a theoretical *way forward*, but it also opens to a number of other moral and practical problems. Similarly to the conclusions derived from the case-study of Chapter 4, which demonstrated the strict site-specificity of the elements underlying the different land use planning in at-risk areas methods developed by Member States, I would conclude that proposing an equally applicable "method" for enforcing the ethical framework proposed in the previous Chapter is neither feasible nor appropriate.

Coming to the main question, I would however conclude that the indication of the objective of *spatial safety equality* at European regulatory level would not represent a friction with the mandate of the European regulation. This conclusion was in fact based on ethical considerations, similar to those addressed for the other two obligations of information and improvement which are already reflected in the scope and requirements of the Seveso Directives. Art 12 may provide an indication in this direction by including, next to the requirement of ensuring that consultation processes are established when land use planning decisions have to be taken, the requirement of ensuring that these consultation processes include a discussion on the possible forms of spatial compensation that can be allocated to involved communities in the three cases covered by Art 12.

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the different perceptions of and reactions to the facility siting process *tout court*. Whereas in Austria a hierarchical approach to facility siting seemed to encounter major acceptance by the side of communities for example, in Canada and Japan a market approach involving them since the early stage of decision-making appeared to be more appropriate. By contrast, in other contexts the egalitarian orientation of environmental groups and community representatives led to the failure of the siting process from the very beginning (see Linnerooth-Bayer, 2005, *op. cit*.)

Even though this conclusion may be seen as highly subjective, it is fully consistent with the ethical framework proposed in Chapter 3 and the assumption that ethical principles are inherently cross-cultural and hence supra-national. Leaving to Member States the definition of the processes and methods suitable to individualize the spatial compensations to be allocated to at-risk communities, I would therefore conclude that the supra-national indication of the objective of spatial safety equality in the European territory may complete the set of requirements of the Seveso Directives.

Similarly to the conclusions derived in the previous section, these processes and methods should *reflect* rather than *level* the differences of Member States to be effective, and should be sensitive enough to capture and account the unique features of the communities involved in facility siting processes. Hierarchical, market- and egalitarian approaches may be differently applicable depending on the national and local contexts of decision-making processes; however, none of them exclude the possibility of fulfilling the moral obligation of compensating communities, which have accepted their risk inequality freely, by means of compensative spatial benefits. Here, the effort of national regulators should be establishing the processes and defining the criteria suitable to empower decision makers in individualizing both the approach and the spatial benefits that better correspond to their necessities. Communities should be hence regarded in the egalitarian perspective of unique, site-specific and (multi)cultural-specific groups of individuals rather than in the utilitarian perspective of "impersonal" members of society. Empowering them to "decide how to decide" should be hence the underlying scope of deliberative facility siting processes.

This form of what Linnerooth-Bayer calls " robust siting processes" recalls the concept of "reflective discourse" introduced n Chapter 1, which is recommended by Renn in all cases in which decisions about risk are confronted with high residual uncertainty. In the context of the Seveso Directives, this uncertainty is primarily related to the outcomes of risk assessment and to the spatial measures to be put in place for preventing the expected consequences of accidents. However, these consequences are as dynamic as technological and urban developments: "robust" or "reflective" facility siting processes, involving communities since the early-stage of decision-making, would therefore find a proper collocation in the context of ordinary spatial planning processes rather than *ad-hoc* technical assessments. The role and competences of spatial planners during risk decision making processes is of primary importance in this perspective. One reason is the major vicinity of the perspective of spatial planners to the perspective of citizens in comparison to risk analysts, which is the discussed perspective *from the territory to the establishment* rather than *from the establishment to the territory*. The focus of evaluations is, in the first case, wider and more variegated than in the second; planners are more open to capture the social and cultural signals marking the territory, and their interpretation of concepts such as *risk* and *uncertainty* may mirror the ordinary interpretations of citizens in the view of complementing those of risk analysts. Finally, planners should hold the long-term responsibility of individualizing and concretizing the spatial benefits to be allocated to communities living in the vicinity of establishments, balancing them against the overall urban context and mediating the inevitable conflicts which may arise between different stakeholders.

In a way, it may be said that planners are indeed the proper mediators between different and sometimes difficultly combinable perspectives; to the effort of acquiring the necessary technical understanding of the matter of industrial risk, the compensation of enriching it would be therefore associated.

6.4 Beyond methods and cultures: concluding remarks

One of the most interesting outcomes of Chapter 4 is the demonstration that the methods developed in Europe for preventing the consequences of major accidents through land use planning are not only informed by a different rationale, but also by different cultural orientations.

Concerning the rationale, one of the main differences consists of the consideration of the probability of accidents as a decisional element for the definition of hazard reduction measures. As reported in Chapter 4, despite a recent tendency to formulate risk-oriented policies, the consequence- and risk-oriented methods are still representing the two different methodological options developed and adopted by Member States. The usual attributes related to these methods are "more conservative" in the first case and "more accurate/complex" in the second case (Cozzani *et al* 2006, Christou *et al* 2006).

These remarks were confirmed by the findings of the case-study. Here, the comparison of the hazard reduction actions which would be taken as a consequence of two of the analyzed methods, the Dutch and the French methods respectively, demonstrated how the major emphasis on the long-term modification of the territorial context promoted by the Dutch approach would lead to a major decrease of vulnerability of the area of Piombino. This would result, at least theoretically, in a diffuse increase of safety. The *spatial benefits* associated to the Dutch territorial interventions are hence theoretically higher than the spatial benefits associated to the elimination of a risk-source, which would have been prioritized by the then French legislation. In this perspective, the risk-oriented Dutch method doesn't appear to be less conservative, but rather more sensitive to the concretization of safety from the territorial perspective. The major sensitivity to the inventory of substances associated to the then French consequence-oriented method in fact doesn't "act" on the decrease of the " integral" vulnerability of the context, but rather on the " punctual" elimination of a risk-source. When decision-makers have a limited set of actions which can be taken, it is therefore questionable whether the elimination of a low probability / high consequences scenario should be prioritized with respect to an integrated reduction of vulnerability of the area of concern.

Concerning the " more or less" complexity of the two methods, notably whereas the Dutch method relies on both individual and societal risk indexes, the French method relies exclusively on individual risk assessment; furthermore, the former includes risk from transportation whereas the latter focuses only on risk from dangerous installations. It is therefore reasonable to consider the Dutch method as more complex than the French one, and to interpret the integrated interventions resulting from it also in the light of this complexity.

One of the conclusions derived from the case-study is hence the major consistency of the Dutch risk-oriented method to the prevention of the consequences of accidents from a spatial planning perspective. This conclusion seems to be reflected by the following developments of the French legislation, reflecting the *lessons learned* from Toulouse, and the relevant Communication of the European Commission[475], wherein probabilistic considerations are included and mentioned respectively.

At this point, how to explain the resistance of countries like Germany in regard of risk-oriented regulations and the persistence of consequence-based methods in some European practices?

The case-study offers limited support for replying to this question; based on a great number of assumptions, it might be not fully representative of those real-cases in which long-term and effective territorial measures are implemented regardless the methodological orientations of legislations. However, or maybe in the light of this remark, the persistence of methodological orientations favouring consequence-based land use planning evaluations may be explained on

[475] European Commission (2002), *op. cit.*

political grounds. In uncertainty-avoidant cultural contexts such as Germany for example, establishing levels of risk acceptability on the basis of explicit probabilistic considerations may be perceived as problematic by the side of the regulator. Furthermore, the constitutional relevance of the precautionary principle may clash with the adoption of explicitly probabilistic methods in legislation[476].

The discussion over the political relevance of the adoption of consequence- rather than risk- oriented methods may be developed in an even more distinctive direction. In the Questionnaire of MAHB reported in Annex 1 of Chapter 4, question A1 over the method used for land use planning evaluations provides two categories of consequence-oriented methods: methods accounting the "worst scenario" and methods accounting the "worst-credible" or "representative" scenario. The German representatives of the EWGLUP opted for the second category in their reply. In order to develop a discussion over the German methodological " deterministic" orientation is therefore essential reflecting on the concept of "worst credible" or "representative" scenarios.

Accounting the *credibility* of accident scenarios does evidently imply a consideration of their *likelihood*. As previously discussed by recalling the seminal work of Kaplan and Garricks[477], questioning the credibility of worst accident scenarios by looking at their (very low) probability is essential to define preventive measures. This can be linked with the official Guidance for the implementation of Art 12 when it indicates the principle of *proportionality*: would accounting the probability of the worst case scenario, without any credibility consideration, lead to *proportional* hazard reduction measures? Not necessarily.

As argued in Chapter 2, the "essence of risk" can be re-formulated by the function reported below:

$$R = f(p\{s\}, c\ \{s\}) \qquad (4\ bis)$$

In this formalization, the probability and the consequences of unwanted events are derived by the scenario *s*. Somehow, the selection of the scenario relevant to a given substance and process (for example, the selection of BLEVE for pressurized flammable liquids tanks)[478] does hence precede the calculation of its probability. As explained before, whereas the latter is very low[479] and the type of event considered too unlike, the scenario may be deemed *not credible enough* for being used as the *reference* scenario for preventive and hence land use planning purposes. This is the indication provided by the Guidance for the implementation of Art 12 adopted by the European

[476] This remark was confirmed by the German representatives of the EWGLUP during the MAHB investigation of 2004 (refer to the German questionnaire). This information is not publicly available and has to be required to MAHB; it is however mentioned in the relevant Technical Report edited by in 2008. Refer to C. Basta *et al* (2008), *op. cit*, at 62

[477] Reported by B.J.M Ale (2007), *op. cit*.

[478] BLEVE is the acronym of Boiling Liquid Expanding Vapor Explosion. The acronym was introduced after B. Smith *et al* in 1957. The analysts investigated the causes of an accident leading to the catastrophic explosion of a LPG tank and concluded that the dynamic of the accident was due to the sudden loss of pressure and drop of temperature of the overheated and pressurized liquid following the rupture of the tank: it was hence due to the physical before chemical properties of the substance and in principle, to what we may observe in our water heaters and any overheated and pressurized liquid tank. See S. Simonetti (2002), *op. cit*., at 69

[479] There is consensus in literature that "very low" or " negligible" refers to probability of occurrence $< 10^{-6}$/year. See Kirchsteiger *et al* (1998), *op. cit* and Christou *et al* (2006), *op. cit*.

Commission in 2006, stating that "[…] *there is good consensus for not necessarily selecting worst-case scenarios in risk assessment for land use planning purposes* […]"[480]

This indication is consistent with the German methodological orientation, by means of which safety distances are defined on the basis of pre-selected worst *credible* scenarios by looking solely at their consequences. However, having specified the meaning of *credibility* in this context, it may be questioned whether this orientation is purely consequence-based. Rather than purely deterministic, this orientation shall be rather considered as *implicitly* probabilistic: if the probability of reference scenarios was accounted as a criterion for their very selection, an implicit probabilistic judgment was performed prior to land use planning evaluations.

A second aspect of the German approach which may confirm an implicit probabilistic orientation is the strong emphasis given to the BAT (Best Available Technology) principle which was explained in Chapter 1. The rationale of the implementation of the principle in the safety management system of Seveso establishments is the same of deterministic planning approaches based on worst credible scenarios: if the population and the environment in the surrounding of establishments are protected from the consequences of the worst credible events, they are also protected from all other, less impacting accidents. Equally, if the risk at-source is minimized by means of the implementation of the BAT principle, population and environment are reasonably exposed only to a negligible residual risk. However, as further explained in the Guidance for the implementation of Art 12, "*risk is taken implicitly into account in the definition of the "state-of-the-art* (of technology)"[481].

In conclusion, consequence-based methods like the German one appear to involve implicit probabilistic considerations, specifically when selecting worst *credible* or *representative* reference scenarios and when referring to principle like BAT in the safety management system of Seveso establishments. In fact, when dealing with risks decisions are inevitably based on probabilistic considerations, without which preventive measures may become disproportional. Even though the distinction between *implicitly* and *explicitly* risk-oriented methods is valid in principle, the German case demonstrates that the option for the former and its adoption in legislation may respond also to political beside methodological considerations.

Beyond methods and cultures, the room for harmonization of the European approaches to the matter of land use planning in Seveso areas is therefore represented by the reference to the same set of reference scenarios rather than by the adoption of the same method. Without referring to the same reference scenarios, it is impossible to compare and select the method which is most appropriate to the national context and evaluating the relevant outcomes from the variety of perspectives which were examined in the course of this book. Furthermore, the vulnerability of the context surrounding Seveso establishments should also refer to a consistent set of criteria and indicators. Keeping in mind the conceptualization of risk proposed in section 6.1, whereas the subjective value associated to certain vulnerable targets (such as historical buildings or sensitive natural environments) may differ across Member States, and obviously across members of the same community, the evaluation of their *intrinsic* value and of their intrinsic and extrinsic vulnerabilities should appeal to a common set of criteria. In particular, the evaluation of vulnerability of the natural environment and the evaluation of its compatibility with the presence of dangerous installations should be included in the same set of instruments providing the information relevant to the risk to humans, such as Safety Reports and land use planning instruments.

The Guidance adopted by the European Commission in 2006 represents a step in the direction of a common European reference scenarios database; the outcomes of the F-Seveso investigation conducted in 2008 are instead consistent with the proposal of defining common

[480] Christou *et al* (2006), *op. cit*., at 29
[481] Christou *et al* (2006), *op. cit*., at 24

criteria for evaluating the vulnerability of human and natural targets exposed to the risk of accidents[482]. Whereas the first issue is in a more advanced state of development and does increasingly attract the efforts of the risk analysis community, the second is in a rather early stage of development and relies on a minor number of studies. In the following section, suggestions for further research are therefore proposed.

6.5 From multi-dimensional risk to a multi-risks approach. Suggestions for further research

One of the premises of this book was that risk is a matter that regards a variety of aspects of human life and, in particular, of the technological developments advancing our society. One of the merits of Authors such as Ulrich Beck has been the one of addressing the matter of risk in a systemic perspective, in so doing promoting a perspective on technological risk, together with its counterparts, as intrinsic elements of modernity. Written at a time in which the ecological perspective on economical and social studies was moving its first steps (Scandurra 1996), the seminal work of the German sociologist had the merit of promoting a new perspective on the increasing threat represented by the sometimes dramatic social and environmental impacts of technologies, enhanced by the increasing interconnections linking the man-environment-technology system. Indeed Beck has been among the first scholars who have approached a matter that is still more ordinarily falling under the umbrella of technicians and analysts rather than scholars of sociology and ethics. In so doing the German scholar initiated the "social debate" on the systemic nature and intergenerational consequences of technological risk that kept developing during the 90's of the last century and is, nowadays, more lively than ever.

However, the misleading generalization of *all* technological risks as intrinsically systemic and necessarily intergenerational remained the perspective adopted by this book. Approaching the threat of a pandemic flu, the installation of nuclear power plants and the location of a LPG fuel-station adopting the same optic is a dangerous generalization, as it leads to leave aside those distinctive aspects of different technological risks which are fundamental both to their understanding and ultimately prevention. Several steps in this direction were made in the last two decades, for example through the works of scholars as Renn, De Marchi, Funtowicz and Slovic from the side of sociological and psychometric perspectives on risk and the contributions of Amendola, Ale and Christou from the side of the risk analysis. The common denominator of the contributions of these scholars is the acknowledgement that technological risk, and industrial risk in particular, cannot be neither described nor prevented without taking a multi-disciplinary perspective, accounting the different site-specific elements of specific situations and their different "meanings and contextualization" perceived by different stakeholders.

This book has focused on one particular type of risk and has analyzed some of its features in the context of the relevant European regulatory framework. This led, on the one hand, to write a book of extreme specificity and, on the other, to derive rather general conclusions. The declared limit of the investigation has been the one of not narrowing the analysis down to specific dangerous installations and verifying, in so doing, the applicability of these conclusions to the whole set of establishments covered by the Seveso Directives; it is indeed reasonable to expect that different type of installations would lead to perform sociological considerations similar to those of Ulrich Beck, and hence to question the desirability of certain chemicals, whereas other types of substances

[482] Refer to O. Salvi *et al* (2008), *F-Seveso. Study on the Effectiveness of the Seveso Directive*, EU-VRI, online. Available at: http://ec.europa.eu/environment/seveso/pdf/seveso_report.pdf . Last visited: December 2008

would be better approached from a rather simpler perspective that those proposed in some parts of the book.

However, the merit of the investigation has been the one of providing a rigorous comparison of different national implementations of the land use planning requirements of the Seveso Directives, shedding light to some interesting aspects of national practices and providing, in so doing, a variety of interpretational instruments to planners and policy-makers working in the field of risk prevention. This research was indeed conducted in an "operational" rather than academic context, and tried to provide some key-of-readings of the matter of risk in land use planning of practical rather than theoretical flavour. Whereas the book fails in providing an equally applicable method to resolve the matter of land use planning in Seveso areas, defending the site-specificity of solutions together with the generality of the ethical obligations to be accounted prior to perform the proper evaluations, it provides an enlightening overview of the constellation of diversities shaping European national risk prevention policies and, in so doing, proposes itself as a platform from which more focused, or more general, investigations may depart.

A first indication in this regard is the sure limitation which will be posed by approaching the matter of risk in land use planning on risk-by-risk basis. Whereas focusing on one type of technological risk was necessary for performing a focused comparison of European national practices, the same approach in spatial planning instruments would lead to rather ineffective evaluations and to the definition of limited if not erroneous hazard reduction measures. Natural hazards and complex phenomena as climate change are simultaneously threatening areas affected by industrial risk. Harbour areas such as Rotterdam and Venice are examples of this kind. Regulating the dislocation of industries, population and environmental areas on the basis of a one-risk evaluation may be easily lead to augment the vulnerability of the same targets to other forms of risk and hazards.

Mark Fleischauer[483] and Schmidt Thomé[484] have investigated the matter of integrating the prevention of natural and technological risks, together with climate change, in spatial planning instruments. Both Authors tackled the matter of "filtering" the hazards relevant to spatial developments in the context of the European Spatial Planning Observation Network (ESPON)[485]. In the final report of the ESPON project, a classification of risks according their spatial relevance is proposed. Similarly to the distinction made in this book between site-specific and what may be called α-site risks, the concept of "spatial relevance" represents the relation between hazards/consequences in a given context: "[…] *disasters take place somewhere (…) spatially non-relevant hazards occur more or less anywhere* […]"[486].

Without describing the work of the two Authors in more details, it is important to stress how the challenges and horizons of territorial risk management regard a variety of spatial-relevant risks, as the matter of spatial safety equality embraces contemporarily natural hazards, technological and societal risks such as urban security. The international research is moving only her first steps in this direction, and several research horizons are waiting to be explored.

An second unresolved matter in land use planning in at-risk areas regards the definition of criteria and indicators for evaluating the vulnerability of the natural environment. Whereas there is general agreement regarding the definition of levels of vulnerability of humans, the vulnerability of the environment to the consequences of major accidents is still a fuzzy area, subject to rather qualitative and somehow "secondary" evaluations. One of the outcomes of the investigation of

[483] M. Fleischhauer (2006), *op. cit*.
[484] P. Schmidt-Thomé (2006), *op. cit.*
[485] Refer to Schmidt-Thomé *et al* (2006), *The Spatial Effects and Management of Natural and Technological Hazards in Europe*, ESPON
[486] M. Fleischhauer (2006), *op. cit.*, at 7

Salvi *et al* concerning the effectiveness of the Seveso Directives[487] is the demand, by the side of European chemical industry representatives as well as safety authorities, of a clear and consistent indication concerning how to approach the matter of the natural environment in the context of the Seveso Directives. Whereas several scientific contributions and national legislations offer an indication in this direction, this area of one of the problematic areas of risk prevention in land use planning that seems to be in need of an innovative methodological foundation rather than a corollary of indications.

Other research horizons may be explored starting from the outcomes of this investigation. More than new research trajectories, they seem to follow the historical routes of unresolved challenges. However, the Chinese ideogram for *challenge* is the same as that of *opportunity*, and in front of the prevention of the consequences of contemporary risks, we may see an opportunity for overcoming the limits of a mono-disciplinary approach to our most fundamental decisions.

6.5.1 Measuring the immeasurable: the real dilemma or the wrong problem-formulation?

In Chapter 1, 2 and 5 I insisted on the necessity of performing multi-dimensional evaluations of the consequences of risk, proposing the model of *extended* risk concept of van Breugel as the proper guidance. An unresolved matter here would be "measuring" these dimensions according to indicators capable to " capture" their potential of disruption in the case of occurrence of accidents. One of the limitations that policy-makers, planners and risk analysts would surely see in the practical application of this approach would be indeed the impossibility of "quantifying" the potential of disruption and, therefore, ranking them prior to take relevant decisions.

Is this the real dilemma, or rather the wrong problem-formulation?

Models as those of van Breugel, and generally all qualitative conceptualizations of complex matters that are proposed as guidance to decision-making, shouldn't be interpreted as "tools" but rather as "instrumental concepts". They are in fact explanatory rather than distinctive, and serve to *guide* rather than to *resolve*. An interesting research to be conducted starting from the model of van Breugel would hence not be the one trying to resolve the matter of its quantification, but the matter of its operational translation during real decision making processes.

The same applies to the conceptualization of risk proposed in Chapter 1 and further in the Conclusions. Rather than "measuring" the options and goods that humans value, for example through the application of pre-defined indicators, the validation of this conceptualization of risk should pass through its application in a set of real decisional processes. This would lead to observe the dynamics among stakeholders which would be promoted in front of the challenge of understanding, for example, to what the real members of a community give more value in their territory or life-styles. Furthermore, it would lead to observe the different forms of investigations which would be conducted (for example, interviews, public enquires, online consultations, etc) in order to achieve this understanding. It is reasonable to expect that in different contexts, these dynamics and investigations would be radically different beside leading to radically different results; but these differences are what validate the appropriateness of the approach, as its purpose is capturing and not levelling them.

By promoting a form of "exchange of worldviews", the proposed conceptualizations of risk would have already accomplished to one of the most difficult requirement of robust risk decision making processes: the one of capturing and accounting different interpretations, perceptions and stakes in practical beside theoretical terms. Researching in this direction would hence involve

[487] O. Salvi *et al* (2008), *op. cit*.

leading and observing the different routes which would be followed by proposing these models in a set of real cases, and striving for conclusions over the desirability of their application. My ambitious assumption is that in any case, these models would not diminish but rather augment the richness of contributions which would be brought into discussion, and would help to avoid poorer rather than more grounded decisions.

6.5.2 When subjectivity threatens equality

As argued by Kneese, if all dangerous activities are to be restricted unless they have the consent of the communities exposed to risk, industrial society would be paralyzed[488]. However, if the same communities are not empowered to take part to siting processes, many of them do and would result in undesirable conflicts and ultimately in a failure.

The matter of equality is not new to risk studies. Many authors have tackled its resolution by appealing to cost – benefits analysis, utilitarian ethics, egalitarian principles and hierarchical approaches to policy-making among other approaches.

The one chosen in the course of the book balances deontological and utilitarian (hence consequentalist) considerations. The deontological perspective on risk inequality defends the necessity of ensuring an equally high level of protection to humans and the environment by establishing binding thresholds of risk acceptability. Residual risk should be low enough in society to not represent a threat to the primary right of life. However, implicit to the concept of *residual* risk is the matter of residual risk inequality. The utilitarian perspective to risk inequality appeal to market-approaches in facility siting, advocating the justness of compensating communities which have accepted to be exposed to residual risks. This book has embraced this contribution of the utilitarian perspective, and proposed to allocate *spatial* rather than monetary compensations to the communities suffering from an unequal *spatial benefits* distribution.

But what stand behind the general concept of *communities*?

As finely argued by Linnerooth-Bayer, one of the limits of the utilitarian market-approach to risk inequality is the de-personification of the members of society, equal to "numbers" to be computed when the Pareto efficiency has to be calculated. Differently, members of communities are intrinsically unique and specific, and the optimum Pareto efficiency may correspond to high levels of dissatisfaction among the real members of society who are affected by utilitarian considerations.

To the proposal of an ethical framework for regulating the siting of dangerous establishments, which may lead risk decision processes to comply with the obligations of information, improvement and compensation, a more concrete definition of the roles of authorities and the power of members of actual communities should hence follow. Do the latter in particular have the right of veto? Or do they have only the right to negotiate compensation? Who's the final decision-makers, and how the transaction of property-rights is regulated? Is compensation financed through a taxation system, and hence externalized by Operators, or is the internalization of compensative spatial benefits costs more desirable in a democratic society?

These questions were left unresolved by this book. A general assumption is that, in real cases, the subjectivity of individual perceptions will come into play during decisional processes, particularly in the phase of risk characterization and the negotiation of additional spatial benefits. Some members of real communities may oppose the decision of hosting the establishment *tout court*; some others would not accept the spatial benefits " package" offered as compensation and some others would delegate the decision to authorities, relying on their capacity to act in their best interest. How to account these different perceptions and stakes? Is the majority that decides, or one

[488] A. Kneese (991), Unpublished congress paper, Reported by Linnerooth-Bayer (2005), *op. cit*., at 47

single opposition on the ground of primary rights should lead to drop the proposal of installing the facility? In this circumstance, how to compensate the loss of those who were favourable to the compensation?

Tackling these matters indicates an interesting research trajectory that, similarly than to the others which were proposed, can be only followed by means of a direct involvement of the relevant further investigations in real controversial cases.

6.6. Risk analysts, spatial planners and communities: towards an effective interdisciplinary dialogue

During the various stages of elaboration of this book I was often involved in technical discussions that, especially at the beginning and periodically after, I wasn't into a position to contribute to effectively. As a spatial planner playing in the arena of risk analysts I often experienced the frustration deriving from the lack of in-depth understanding of the technical aspects of industrial risk analysis, particularly regarding the different analytical methods used in risk assessment and their relevance to different substances and industrial processes. This sort of expertise is indeed acquirable only by means of practical experience, and practical experience is only acquirable by means of years of professional activity; risk analysis courses and handbooks are not sufficient to bridge the gap between a non-expert and so-called *experts*.

The distance between the disciplinary backgrounds of spatial planners and risk analysts leads often the former to abandon the evaluation of risk in land use planning solely in the hands of the latter. However, I insist that the planning discipline and the ordinary practice of spatial planning have a valuable and necessary contribution to provide to risk assessment and prevention processes and, necessarily, to long-term land use planning evaluations. Nevertheless, in several European countries the latter are performed by means of the *ad-hoc* technical advice of risk analysts, which are then "attached" to (mostly local) planning instruments in the form of Technical Annexes.

Whereas this is a necessary and respectable practice, I question whether its outcomes are sufficiently embedded in the complexity of the territorial, economical and social evaluations reflected and projected by planning instruments. Treating the dislocation of Seveso establishments and the urban development in their surroundings as *ad-hoc* technical evaluations leads decision-makers, and planners in particular, to miss the opportunity of performing the multi-dimensional and interdisciplinary evaluations of industrial risk proposed in this book. Furthermore, planners miss the opportunity of extending their competence to a matter which is increasingly crucial in spatial planning, and the possibility of developing innovative approaches to its "spatial governance". Reaching what we called *safety spatial equality* passes through an integrated vision of the territory, not through the resolution of isolated and sometimes controversial land use planning matters.

Whereas there is agreement in theory, in practice there is still a resistance by the side of risk analysts and some shyness by the side of spatial planners to open to the interdisciplinary contributions which may enrich and complement their evaluations of risk. This resistance, in the first case, reflects the somehow historical, and in principle understandable, predominance of the contributions of natural and applied sciences to the resolution of problems characterized by high technicality. The contributions of spatial, social and political sciences are often a corollary, but rarely an equally determinant input, especially in less mature legislative and professional contexts.

Our society cannot afford to maintain such a rigid division of roles. The two last centuries have been the centuries of technocracy, growth and innovation; our century is the one during which reflecting on the ever known forms of uncertainties that were so created, and accepting that some of them are simply irreducible. But where science is no more capable to provide us with answers, then ethics may help us in making the right questions. Our time is the precious time during which

abandoning the ambition of predicting the future, and embracing the possibility of choosing it. This choice doesn't regard nor can be solved by any privileged disciplinary domain, as it regards the whole human community; and time by time, it regards what Funtowicz has rightly defined as the *extended* peer community confronted with it.

During the final editing of this manuscript a chemical engineer asked me how would I have dealt with the uncertainty of the outcomes of a sophisticated accident scenarios modelling, revealing that the risk arising from a Seveso establishment is at the edge of legal acceptability; and what would I have done if I had a crucial land use planning decision to take, a little budget at disposal and the pressure of the major of the hypothetically involved municipality.

I replied that I would have taken *time*. And that I would have spent my budget to involve the citizens affected by these "uncertain" scenarios in a discussion together with the plant operator, the risk analysts who modelled the scenarios and the major who needed to deliver the plan. The purpose of this involvement in my idea was achieving a shared understanding of this uncertainty, evaluating all possibilities of reducing it, empowering citizens to provide their inform consent to keep living in the surroundings of the plant and evaluating the availability of the other parties of establishing forms of compensation: for example preserving part of the area from further developments and placing a green buffer zone in it.

I was replied that in real cases, this *may not be possible*.

It was, and it may still be difficult to defend the "scientificity" of my reply; but I would find ethically impossible to defend the justness of the reply I was given.

In front of the forms of irreducible uncertainty that may potentially impact the lives of unaware citizens living *at the edge of acceptability*, the justification of not taking actions, or taking the potentially wrong one *because* of this irreducibility, is morally unacceptable. The only way to decrease our uncertainty about risks is witnessing their manifestations into harms, and having more case-histories at disposal; but this "perfected knowledge" is exactly what risk analysis wishes rather to avoid. This aim of avoidance is not mandated to scientific thinking; it is solely mandated to universal ethical principles. If the matter of "being at the edge" cannot be resolved by performing further analysis, then decisions have to be taken by replying to a newly formulated moral question: if it's mathematically *almost* acceptable but inherently *highly* uncertain, would be then the possible consequences morally justifiable?

Also *taking time* and initiating a discussion with all the parties of the example mentioned above would be not, *per se* , a reply to this question. However, making it would probably lead to re-formulate the problem, and surely to opt for the solution which all affected parties believe being the right one. In those situations in which individual arguments – which represent what in science are called *stakes*- would clash against each other, I firmly defend the moral obligation of risk analysts and spatial planners of not hanging necessarily in favour of the most scientifically grounded; but of the most ethically driven.

With some time in between I hence realized that this chemical engineer and I were just trying to give a reply to two different questions. To me, his question was related to the process that I would have initiated to address, and eventually resolve, a conflicting situation; to him, his question was related to the resolution of the problem I would have proposed on the basis of the constraints and limited information he had given me. So whereas his questions was focusing on the *method*, my reply focused on the *process*, and has therefore instinctively included all the subjects involved in the example; forgetting that part of them didn't compare among the variables of the problem he had formulated.

However, history teaches us that it is indeed the formulation of the right problem that matters. The most catastrophic accidents of history happened after sometimes sophisticated risk analyses were performed. In most cases, the yet surely relevant social and spatial planning

evaluations where given minor importance. Ethics came into play when the accidents had already happened. In front of this reality, minimizing the relevance of the cooperation among risk analysts, spatial planners, social scientists, scholars of ethics, environmental groups and ultimately citizens in front of the challenge of preventing the consequences of industrial risk is not only an outdated vision, but also a tragically incorrect one.

There is no model or research finding that would ever provide a way forward to this problem. Interdisciplinary and collaborative dialogue rests in the will of individuals of encountering and listening to the other ones, not in refining theoretical models of easy practical avoidance. At the end of this book, my wish is hence having provided some incentives to each side to open to the other ones.

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Samenvatting

In 2004 heeft het Major Accidents Hazards Bureau van het Joint Research Centre van de Europese Commissie het onderzoeksprogramma "Ruimtelijke Ordening Inclusief MAHB en NEDIES" gelanceerd. In de context hiervan is het merendeel van het onderzoek in dit boek uitgevoerd. In dit onderzoek ligt de nadruk op de verschillende methodes die door de Lidstaten waren ontwikkeld voor het implementeren van Art. 12 van de Seveso II Richtlijn, waarin de eis van *Controle van Verstedelijking* is vastgelegd. Art. 12 is het eerste Europese vereiste waarin Lidstaten worden opgeroepen "te garanderen dat de doelstellingen om zware ongevallen te voorkomen en het beperken van de gevolgen van dergelijke ongevallen worden opgenomen in hun ruimtelijk beleid en andere relevante beleidsgebieden." Het doel van het MAHB-onderzoek was een volledig bijgewerkt overzicht te geven van de implementaties op nationaal gebied van Art. 12 om zo te komen tot een relevante Leidraad en de Lidstaten te voorzien van aanvullende ondersteunende instrumenten. De Europese Commissie heeft deze Leidraad in november 2006 aangenomen. Het onderzoek, dat zich baseerde op enquêtes, literatuur en directe interviews met de leden van de Europese Werkroep op het gebied van Land Use Planning (EWGLUP), heeft geleid tot het uitwerken van een tweede ondersteunend instrument, de zogenaamde Roadmaps. In dit onderzoek worden de verschillende methodes, die ontwikkeld zijn voor de implementatie van Art. 12, door een selecte groep van Lidstaten (Nederland, het Verenigd Koninkrijk, Duitland, Frankrijk en Italië) weergegeven.

In de herfst van 2004 was dit promotie-project betrokken bij het onderzoek ten behoeve van de Roadmaps en de uitwerking daarvan. Terwijl dit laatstgenoemde onderzoek zich beperkte tot het weergeven van de verschillende benaderingen, ontwikkeld in de Europese Unie, zal in dit promotie-onderzoek geprobeerd worden deze uit te leggen. Welke zijn de karakteristieke elementen van de verschillende nationale benaderingen van Art. 12? Waardoor is de ontwikkeling van de verschillende methodes van ruimtelijke ordening in de "Seveso"gebieden en andere relevante legislatieve implementaties bepaald? Leiden de verschillende benaderingen tot een verschillend niveau van preventie? Hoe beïnvloeden de politieke en culturele zienswijzen de legislatieve implementaties. Wat is tenslotte de rol van en welke zijn de gezichtspunten van de Europese regelgeving in het licht van deze verschillen?

Om deze vragen te beantwoorden begint het boek met het geven van bepaalde richtinggevende definities die relevant zijn inzake het industriële risico bij de ruimtelijke ordening. Deze definities zijn wezenlijk voor het lezen van het boek voor de lezer die niet zo bekend is met de terminologie op het gebied van risicopreventie, aangezien planners en beleidsmakers de primaire doelgroep van dit boek zijn. Verschillende definities van risico en de verschillende hiermee samenhangende concepten worden geanalyseerd, in combinatie met de hiervoor gebruikte terminologie in de literatuur. Hierbij worden verschillende zienswijzen inzake risicopreventie op technologisch gebied geïntroduceerd. Het paradigma van "risk society" (Beck 1992) wordt besproken en over enkele van de controversiële interpretaties

ervan wordt duidelijkheid gecreëerd door belangrijke verschillen tussen de verschillende typen risico's, namelijk natuurlijk vs. technologisch en systemisch vs. specifieke gebiedsrisico's aan de orde te stellen.

Hierna zullen alom bekende ongevallen en de daaruit getrokken lessen beschreven worden. De beperkingen van een typering vanuit één enkele dimensie van het risico in ruimtelijke ordening worden besproken en een multi-dimensionele kenschetsing van de gevolgen van ongevallen wordt gegeven. Het boek voorziet vervolgens in een alomvattende analyse van de ontwikkelingen in de regelgeving van de Seveso Richtlijnen van 1982 tot 2006 en van de "lessen die getrokken zijn uit ongevallen", die hun weerspiegeling vinden in het doel en de vereisten van de Richtlijnen. Deze

lessen worden bekeken door een multi-dimensionele lens, welke aan bod is gekomen in de voorafgaande hoofdstukken: zou de loutere berekening van de vergelijking van de "essentie van risico" de politieke, ethische en sociale gevolgen omvatten zoals in Bhopal in 1984? Deze kwestie vraagt om een gedegen ethische reflectie. De ethische beginselen die van toepassing zijn op het beheersen van risico's van zware ongevallen en de hieraan gelieerde kwestie van de aansprakelijkheid worden daarom ook besproken. Een passend ethisch raamwerk voor het richtinggeven van verdere Europese ontwikkelingen in regelgeving en conclusies betreffende de wenselijkheid van een regelgevend systeem en ex-post aansprakelijkheidsregels worden hier beschreven.

De kern van het boek is de vergelijking van de verschillende nationale implementaties van Art. 12. Hiervoor zijn de variabelen onderzocht (kwantitatief vs. kwalitatief) die de verschillende methodes en beleidskeuzes zouden kunnen verklaren. In het bijzonder worden de deterministische vs. probabilistische methodes vergeleken door middel van een gevalsanalyse. Hoewel de eerste aanpak gevoeliger bleek voor een inventaris van schadelijke stoffen en daarom ook een stimulans om deze te verminderen door vermindering of dislocatie, blijkt de tweede aanpak de toename van een veiligheidsbeoordeling van inrichtingen en het terugbrengen van de kwetsbaarheid van de omliggende gebieden te stimuleren. Over het algemeen kan derhalve geconcludeerd worden dat het het onderliggende doel is, en niet het resultaat van evaluaties inzake ruimtelijke ordening, waardoor de keuze wordt bepaald voor één van de twee methodes. Hierbij kunnen de demografische variabelen en de context van de nationale regelgeving van doorslaggevend belang zijn. Vanuit dit oogpunt wordt bevestigd dat de keuze tussen de twee richtingen veeleer bepaald wordt door de politieke en ruimtelijke context van regelgeving, dan door overwegingen van methodiek.

Een derde en in zekere zin complementaire analyse, benadrukt de culturele variabelen die de adoptie van verschillende benaderingen over de algehele kwestie van ruimtelijke ordening in Seveso gebieden heeft beïnvloed. Hierbij zijn de culturele theorieën van Hoffstede als referentie gebruikt om enkele interessante conclusies aan de orde te stellen aangaande het bestaan van een "culturele oriëntatie" in beleid inzake risicopreventie. De nationale culturen in Europa, die de Nederlandse socioloog classificeert als risico-avers, komen overeen met de regelgevende context waarin een semi-kwantitatieve of deterministische benadering wettelijk voorgeschreven is. Zelfs hier blijkt risico-regelgeving een onderdeel van nationale politiek te zijn.

De conclusies van dit boek vatten de bevindingen zoals deze zijn besproken in de ontwikkeling ervan samen. De ethische, wetgevende en culturele elementen die bepalend zijn voor de verschillende "roadmaps" voor ruimtelijke ordening in Seveso-gebieden worden aan de orde gesteld. De belangrijkste onderzoeksvraag die wordt beantwoord in de conclusies betreft de "beperkingen en mogelijke voorspellingen" van een gemeenschappelijke regelgeving in het licht van deze, soms opmerkelijke verschillen. In beginsel houdt de Europese regelgeving een verantwoordelijkheid voor Lidstaten in met een supra-nationaal raamwerk voor regelgeving dat volstaat om de beperkingen van de nationale wetgeving en maatregelen te overstijgen, terwijl legitieme, culturele en politieke oriëntaties en specifieke gebiedsfactoren het werken met verschillende methodes van benadering inzake industrieel risico in ruimtelijke ordening bepalen. Zware industriële ongevallen zijn mogelijk grensoverschrijdend; verder zijn de verplichtingen die voortvloeien uit Richtlijnen zoals de Seveso Richtlijn noodzakelijkerwijs cultuuroverschrijdende morele verplichtingen. Kunnen deze en de instrumenten om aan deze te voldoen, beter in een raamwerk op Europees niveau worden weergegeven?

Enkele voorstellen worden hier gegeven. Het eerste is een voorstel om van een multi-dimensionele definitie van (de gevolgen van) risico op het niveau van een Europees raamwerk aan te nemen. In de tekst van de Seveso Richtlijn is risico gedefinieerd als "de waarschijnlijkheid dat een bepaald effect zich binnen een bepaalde periode of onder bepaalde omstandigheden voordoet". Aangezien

het algemene doel van de Richtlijn is de gevolgen van zware ongevallen voor mens en milieu te beperken geven nationale wetgevingen maatstaven om deze te meten zoals gezondheidsrisico's en het verlies van milieu-erfgoed. In eenvoudige bewoordingen: de gevolgen van het betreffende risico zijn doorgaans eenzijdig; de dood van mensen dient voorkomen te worden.
Zoals beargumenteerd in het boek zouden de gevolgen van de ongevallen die de ontwikkeling van de Europese regelgeving niet 'omvat' aan te orde komen bij deze typering. Bhopal blijft i helaas bekend in de geschiedenis omdat het heeft geleid tot het in twijfel trekken van ethische aansprakelijkheid en de wenselijkheid van de chemische industrie op zich en voor het voor het voetlicht brengen van de beperkingen van juridische instrumenten en middelen die ter beschikking staan voor het compenseren van sociale, milieu- en dus lange-termijn-schade die veroorzaakt is door het ongeval. Gevoelig risicobeleid zou daarom de kwestie in een meerzijdig perspectief moeten plaatsen van hun onmiddellijk tastbare gevolgen en ontastbare gevolgen op de lange termijn om een grondigere overweging te stimuleren van de maatregelen die worden genomen voor de preventie ervan.
Deze beschouwingen hebben de weg geopend voor de ethische overwegingen die in de conclusies aan de orde komen. De morele plicht van *informeren, verbeteren en compenseren* is zeker relevant voor het doel van de Seveso Richtlijnen. Echter, waar de eerste met zoveel woorden is genoemd in de daarvoor relevante tekst en de tweede expliciet is genoemd in de tekst van de complementaire regelgeving bij de Richtlijnen, heeft de plicht tot compenseren weinig aandacht gekregen. Het onderwerp van veiligheid als ruimtelijk *benefit* afgeleid door Moroni (Hoofdstuk 2) zou een "stap in de goede richting" kunnen zijn. Overige gebieds-specifieke risico's leiden tot een ongelijke verspreiding van veiligheid in de samenleving; het gelijk trekken van deze ongelijkheid is alleen mogelijk door het toedelen van additionele ruimtelijke *benefits*, die evenwel niet verward mogen worden met het voorzien in additionele technische maatregelen (ATM) zoals voorgeschreven door Art. 12. Terwijl sommige nationale wetgevingen dit probleem expliciet aan de orde stellen, ontbreekt een concrete aanduiding om deze eis af te dwingen op Europees niveau.
Een derde overweging betreft de methodologische oriëntaties van de Europese landen. De veelbesproken acceptatie van deterministische vs. probabilistische methodes en het zoeken naar een op dezelfde manier toepasbaar model om de kwestie van industrieel risico in ruimtelijke ordening op te lossen blijkt niet het echte probleem te zijn. De heterogeniteit van de demografische, economische, ruimtelijke en culturele kenmerken van Europese landen zijn doorslaggevende factoren gebleken in de betreffende processen voor het formuleren van risico's. Kunnen deze ongelijkheden gelijk getrokken worden door een methode die net zo effectief is voor de verschillende processen? Integendeel, deze methodes weerspiegelen deze verschillen en beantwoorden aan gebiedsspecifieke noodzakelijkheden waarvan het niet effectief zou zijn deze te ontkennen. Het vooruitzicht van het onderzoek dat gedaan moet worden op dit gebied is daarom niet het voorzien in een model dat gelijkelijk van toepassing is op de constellatie van diversiteiten van de Europese landen, maar veeleer om beleidsmakers en planners is het bijzonder, van interpretatieve en operationele instrumenten te voorzien die net zo noodzakelijk zijn om tot een allesomvattende en degelijke beslissing te komen.
De genoemde beperkingen van het onderzoek houden in dat het onderzoek niet is uitgebreid naar andere vormen van "hazards and risks" die relevant zijn voor ruimtelijke ordening en dat de bevindingen niet zijn geverifieerd ten opzichte van de verschillen in gevaarlijkheid van stoffen zoals gereguleerd in de Seveso Richtlijnen. Echter, het eerste traject zou de mogelijkheid van een heldere vergelijking van de verschillende nationale oriëntaties in de weg staan vanwege het verschil in wetgevingen en de risicogebieden die onderzocht zouden moeten worden. De tweede zou de richting van het onderzoek afgeleid hebben naar een technisch, meer dan naar een beleidsgeoriënteerde ontwikkeling.

De bevindingen die zijn verzameld in dit boek wegen de twee gezichtspunten tegen elkaar af door, aan de ene kant, te voorzien in een analyse van de mogelijke toekomstige Europese regelgeving die relevant is voor een toenemend cruciale type technologisch risico en aan de andere kant, een interdisciplinair perspectief inzake preventie ervan die passend is om toepassing te vinden bij andere vormen van "risico's in de samenleving".
De leemte overbruggen tussen de verschillende *interpretaties van*, en *gezichtspunten op* risico is hier de belangrijkste uitdaging. Eén van de lessen van dit vijfjarige promotieonderzoek is dat de betekenis van de concepten die graviteren in het universum van "risico" op verschillende wijze wordt geïnterpreteerd door verschillende partijen. De *onzekerheid* van scheikundige ingenieurs is niet de "onzekerheid" waarover planners zullen denken als zij in een discussie zijn verwikkeld. Op dezelfde manier is het *risico* waar analisten het over hebben niet hetzelfde als het risico dat gemeenschappen percipiëren wanneer deze verwikkeld zijn in een publiek debat. Het bereiken van een gemeenschappelijk begrip betreffende deze concepten zal niet tot stand komen door het aannemen van een gemeenschappelijke definitie maar veeleer door het begrijpen van de interpretaties van de anderen.
Interdisciplinair onderzoek zou daarom de instrumenten dienen te leveren om op elkaar te kunnen reageren tijdens interdisciplinaire discussies en niet de "juiste" disciplinaire aanpak te promoten. Het cross-sectoriale publiek waarvoor dit boek bedoeld is in aanmerking genomen zijn de bevindingen van dit onderzoek dan ook voornamelijk bedoeld als een bijdrage in deze richting.

Claudia Basta, april 2009

Short Curriculum Vitae

Claudia Basta was born on August 28, 1976 in San Dona' di Piave, Venice, Italy. She graduated in Architecture with urban planning address at the University of Architecture of Venice (IUAV) in 2003. In her Master thesis she proposed a fuzzy-logic based Decision Support System (DSS) for land use planning evaluations in at-risk areas. The DSS was tested by the Territorial Planning Department of the University of Venice, where Claudia worked as Policy Adviser until the end of the same year. Articles derived from the Master thesis were published in international as well as national journals. Few months after having been admitted to the PhD program in Territorial Economy of the same University, Claudia submitted her PhD proposal to the Faculty of Civil Engineer of Delft University. In April 2004 she joined the Sustainable Urban Areas Interfaculty Research Centre of Delft University. In the autumn of the same year, she was admitted to a Scientific Training at the Major Accidents Hazard Bureau of the Joint Research of the European Commission. Here, Claudia worked closely with the European Working Group on Land Use Planning (EWGLUP) to the elaboration of the Guidance for implementing Art 12 of the Seveso II Directive and the supporting document *Roadmaps*. This extracurricular activity and the heterogeneity of professionals working in the EWGLUP provided her with the inputs and supervision thanks to which she finalized her PhD research.
Claudia joined the Business Unit Innovation & Environment of TNO Bouw (Delft) in the summer of 2006. The following year, her thesis was included in the *Implementatie Risicomanagement* research program of the Delft CLUSTER research consortium. Next to her PhD research she worked on several projects in the field of risk governance until March 2008, when she started to finalize her PhD manuscript. In the meantime, she kept trying to learn Dutch and to become a good Tango dancer.