



ERASMUS MUNDUS  
MASTER OF SCIENCE IN ECOHYDROLOGY



# A critical analysis and proposal of a conceptual multi-hazard framework for natural hazard mitigation and adaptation in the EU policy framework

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Alyssa Serlet

Istanbul, July 2012

## Foreword

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This thesis research has become the crowning glory of my academic career in the Erasmus Mundus Master of Science in Ecohydrology. I would not have reached this point without the motivating support of many people. Therefore I would like to thank them in an appropriate way.

I would like to express my deep appreciation to my supervisor Prof. Dr. Azime Tezer for all her help and support. Thanks to her guidance I have always aspired for the best results. With her great enthusiasm she has also encouraged and inspired me during this research.

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Alyssa Serlet,  
Istanbul, July 2012

## **Abstract - English**

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The assessment and management of natural hazards has received a greater attention in the European Union during the last years. This can be explained by an increase in disastrous events in the EU due to natural hazards which resulted in tremendous economic losses and loss of human lives. The key to decrease impacts is to address the vulnerability of our communities by using mitigation and adaptation measures. These hazard management strategies aim to build on resilience and sustainability. For not ignoring certain risks a multi-hazard approach is necessary.

Policies and guidelines concerning the natural hazard assessment and management are set up on different scale levels. This research work provides a critical review on the current EU policy framework. The analysis addresses the weaknesses and challenges and leads to a proposal of a conceptual multi-hazard framework for natural hazard mitigation and adaptation in the EU policy framework. It is proposed to set up basic standards in a new directive and combine those with official EU guidelines to assist the Member States in achieving those standards.

**Keywords:** natural hazards, multi-hazard, EU policy, mitigation, adaptation

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## **Abstract - Portuguese**

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A avaliação e gestão dos riscos naturais têm vindo a receber uma atenção crescente na União Europeia, nos últimos anos. Esta atenção pode ser explicada pelo aumento de desastres naturais que têm vindo a ocorrer na região, resultando em elevadas perdas económicas e de vidas humanas. A chave para redução dos impactos deve focar na vulnerabilidade das comunidades através da utilização de medidas de mitigação e adaptação que visam aumentar a resiliência e sustentabilidade. De forma a não serem ignorados quaisquer riscos, uma abordagem aos multi-riscos é necessária.

Políticas e instruções relativas à avaliação dos riscos naturais são estabelecidas em diferentes escalas. Este estudo realiza uma visão crítica da política europeia nesta área e identifica as limitações e os desafios atuais. O estudo desenvolveu uma proposta conceptual para uma estratégia de mitigação e adaptação na Diretiva da União Europeia que permita reduzir os riscos naturais. Propõe-se o estabelecimento de critérios base na nova Diretiva, que devem ser articulados com as instruções oficiais da EU, de modo a apoiar Estados Membros na implementação destes critérios.

**Palavras-chave:** Riscos naturais, multi-riscos, políticas EU, mitigação, adaptação

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## Abbreviations

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CI	Critical Infrastructure
ECI	European Critical Infrastructures
EC	European Commission
EEA	European Environment Agency
EPCIP	European Programme for Critical Infrastructure Protection
EU	European Union
FD	Flood Directive
FP7	7th Framework programme for the European Research Area
HFA	Hyogo Framework for Action
HGF	Hyogo Global Framework
MS	Member States
WFD	Water Framework Directive

# 1 Preface

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This research work is conducted in the framework of the Erasmus Mundus Master of Science in Ecohydrology. Within the scope of ecohydrology, a holistic approach is pursued. Therefore it is aimed to combine the objectives coming from all related disciplines (social, ecological, political, etc.).

The writer of this work takes the challenge of investigating current mitigation and adaptation approaches related to natural hazards in the European Union (EU). In the perspective of a multidisciplinary vision, a critical review is given on the current EU policy framework and a proposal for a new conceptual multi-hazard framework is suggested in the attempt to overcome existing challenges.

## 2 Problem definition

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This study is focused on natural hazards (floods, earthquakes, storms, etc.) in Europe. It has been noticed, during last years, that there is an increase in disastrous events in the European Union due to natural hazards. This has resulted in tremendous economic losses and loss of human lives.

There is a strong belief that climate change has a considerable influence in this process. Climate extremes (heat waves, storms, etc.) are growing in frequency and intensity therefore an increase in disasters is to be expected. Climate adaptation has become a well-known concept.

Climate extremes are not the only natural hazards European citizens are facing. Earthquakes for example have caused devastating disasters. In order to be fully protected against disasters all hazards need to be considered. Moreover, the possibilities of hazards occurring simultaneously or consecutive cannot be ignored either. By focusing on single-hazards, great risks are being neglected. Moreover, regulations and actions are not complementary and can provoke other risks. It is therefore necessary to use a multi-hazard approach.

Risk itself does not come from the natural hazard. The vulnerability of our communities is the real catalyst that causes the risks. Increasing urbanisation with growing population is making communities more vulnerable by not being adapted to possible impacts. Unsustainable land use planning is another important factor that has increased vulnerability. The key to decrease impacts is to address vulnerability issues. Mitigation and adaptation measures are hazard management tools aimed to reduce vulnerability and create resilient communities. A comprehensive strategy is indispensable to achieve such objective. For leading such actions towards sustainable results policies are set up.

This study examines the current approaches in the EU by analysing the policy framework. The weaknesses and strengths are described and a proposal is given for a new conceptual multi-hazard EU policy framework.

### 3 Methodology and aim

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The aim of this work is to address the weaknesses and challenges in natural hazard risk assessment and natural hazard management in the EU, with special focus on mitigation and adaptation integrated in a multi-hazard approach. To achieve this goal, a step-wise approach is necessary. Following sub-objectives are connected to the 4 phases in this work (research, assessment, analysis and results) and will lead towards the main aim:

1. Identify the purpose of the research
2. Obtain knowledge within the research area
3. Define the research within the application area
4. Create a tool for assessment
5. Apply the tool on the current EU policy framework
6. Identify weaknesses and strengths
7. Propose a solution with new opportunities and tackle existing challenges

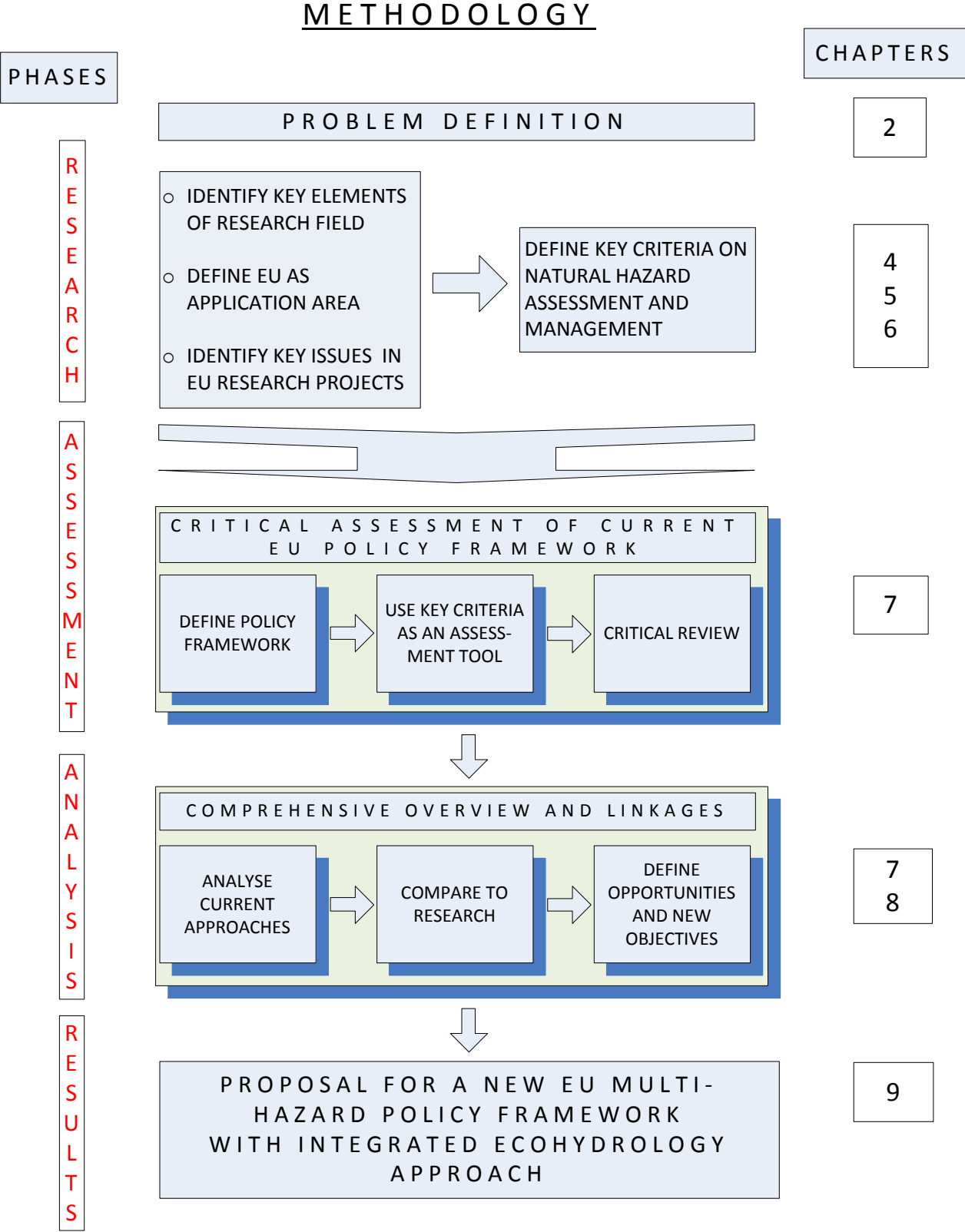
The research methodology (see Figure 1) clarifies the different phases of this work. First the problem definition is addressed in chapter 2.

Following the study starts with the research phase. Key elements within the research field (natural hazards, hazard and risk assessment, etc.) are explained in chapter 4. Additionally, the EU and its Member States (MS) are defined as the application area in chapter 5. The research brings the reader information on the current multi-hazard approaches in the EU by a selection of research projects conducted by EU institutions. Multi-risk assessment and multi-risk management is thoroughly reviewed. Further a link is made with spatial planning tools. Chapter 5 ends with an overview why strategies on EU level are beneficial. Chapter 6 concludes the research phase with defining key criteria on natural hazard assessment and management.

The second phase, covering chapter 7, implies a critical assessment of the current EU policy framework. First the policy framework is defined. The key criteria from chapter 6 are then used as a tool for the assessment which results in a critical overview.

The third phase holds an analysis on previous phases. A comprehensive overview and linkages are presented. By analysing current approaches and comparing this to the research opportunities new objectives are defined by presenting recommendations and new proposals. This phase is conducted in chapter 7 and 8.

This leads to the final phase, in chapter 9, where results are presented. These results are in the form of a proposal for a new conceptual multi-hazard policy framework for the EU.



**Figure 1: Research methodology**

## 4 Literature research

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Natural hazards such as flood, wild fire, earthquake, landslide, etc. are natural events often related to the geological and physical characteristics of the area or to local weather patterns. Some are more predictable than others. (FEMA, 2004) These events can lead to disasters with loss of lives, properties and other assets and affect millions of people every year. Natural disasters have impacts on the entire society with economic, social and environmental consequences. (Guha Sapir, 2012) (Rodríguez-Oreggia *et al.*, 2009) (Committee on Assessing the Costs of Natural Disasters and National Research Council, 1999) (ECLAC-UNEP, 2000)

### 4.1 Natural hazards and climate change

Natural disasters have become more frequent during the last decades. There is a strong belief that climate change has a considerable influence in this process. (Van Aalst, 2006) (Anderson and Bausch, 2006) As climate changes, the probabilities of certain types of weather events are affected. While specific, local outcomes are uncertain, recent assessments project alteration in the frequency, intensity, spatial extent, or duration of weather and climate extremes, including climate and hydro meteorological events such as heat waves, heavy precipitation events, drought, and tropical cyclones (IPCC, 2012). Scientists are still in the process of investigating the human impact on climate change and the consequences of it. Preventive measures such as reducing greenhouse gas emissions have received more attention, both scientifically and from policy perspective, than adaptation measures such as planning and building settlements that can adjust better to the consequences of climate change. However, integrating such strategies into spatial planning and development is becoming a more relevant issue. (La Greca *et al.*, 2010) Climate adaptation and natural hazard adaptation are integrated disciplines and often have common objectives. (Helmer and Hilhorst, 2006)

### 4.2 Vulnerability

The impacts of climate extremes or other natural hazards do not only depend on the hazards themselves but also on exposure and vulnerability. (IPCC, 2012) Vulnerability can be defined as “*denoting exposure to risk and representing the inability to avoid or absorb potential harm*”. (Pelling, 2003) There can be an understanding of physical vulnerability (in the built environment), social vulnerability (experienced by people and their social, economic and political systems) and human vulnerability (combination of physical and social). (Pelling,



2003) Exposure and vulnerability vary across temporal and spatial scales, and depend on economic, social, geographic, environmental, demographic, cultural, institutional, and governance factors. Individuals and communities are differentially exposed and vulnerable based on inequalities expressed through levels of wealth and education, disability, and health status, as well as gender, age, class, and other social and cultural characteristics. (IPCC, 2012) (Cutter, 1996) (Weichselgartner, 2001) Urban areas are considered highly vulnerable to natural hazards, even described as hotspots for disaster risk. More than half of the world's population and the majority of its capital assets are found in urban settlements. Risk comes from increasing poverty and inequality and failures in governance, high population density, crowded living conditions and the sensitive location of residential areas in places exposed to natural hazard. This includes the modification of environments which generates new hazard, e.g. through the loss of protective mangroves to urban development, or subsidence following ground water extraction. (Pelling, 2007)

### **4.3 Integration in spatial planning**

Less developed countries, with weak institutional mechanisms for predicting and responding to natural hazards are surely more vulnerable, but also populations of rapidly and uncontrolled developing countries' unplanned and informal settlements, in spite of sophisticated prediction technology and elaborate civil defence systems. (Hogan and Marandola Jr., 2007) Unsustainable growth of many human settlements endangers the continuity in the future and puts the existing built environment at extreme risk and wastes valuable limited resources. (El-Masri and Tipple, 2002) The vulnerability of populated areas to natural hazards is partly a consequence of decades of spatial planning policies that have failed to take adequate account of hazards and risks in land use zoning and development decisions. Therefore it is critically important to develop more effective methodologies and tools for incorporating natural hazard mitigation and adaptation into spatial planning. (ARMONIA, 2007)

Hazard mitigation and land use planning provide together a powerful approach for reducing vulnerability, and creating more disaster resilient communities. According to Burby R.J. (1998) it is possible to reduce or even eliminate vulnerability to disasters and enhance sustainability by planning and managing land use. This implies a sustainable development where property investments are avoided or limited in hazardous areas, where the mitigating

qualities of the natural environment are maintained, and where disaster recovery offers opportunities to build mitigation into redevelopment. (Berke and Smith, 2009)

Land use plans can be used to analyse the suitability of land for development so that the limitations of hazard prone areas are understood by policymakers, potential investors and community residents. All stakeholders must understand the choices the community is facing and they must reach some degree of consensus. Plans provide guidance for managing development and land use regulations, such as zoning, set specific rules for the private sector on development. (Burby, 1998) How urban planning tools can be applied for mitigating hazards is also explained in the guideline of the ISMEP (Istanbul Seismic Risk Mitigation And Emergency Preparedness Project). (ISMEP, 2009) (Turkoglu *et al.*, 2009)

Land use planning tools that can be used are zoning, subdivision regulations, building codes and financing of capital improvements. Also community involvement by mediation, negotiation, facilitation and policy dialogue provides important benefits in hazard mitigation. These techniques improve the quality of plans and their ease of implementation. The planner is therefore also a mediator and consensus builder and has to engage a wide collection of stakeholders who have a role or interest in the final decisions. The planner must identify complimentary interests and deal with past and proposed development patterns that unnecessarily place the larger community at risk or disproportionately impact the poor or other socially vulnerable populations. (Berke and Smith, 2009)

Spatial planning is responsible for the development of a particular spatial area (where the sum of hazards and vulnerabilities defines the overall spatial risk) and not for a particular object or threat. Therefore, spatial planning must also adopt a multi-hazard approach in order to appropriately deal with risks and hazards in a spatial context. (Greiving *et al.*, 2006)

#### **4.4 Adaptation and mitigation for sustainability and resilience**

Mitigation and adaptation are important concepts related to reducing vulnerability identified with natural hazards. This paragraph explains the concepts, their relation and the interconnectedness with sustainability and resilience.

Natural hazard events cannot be prevented from occurring, but they do not necessarily need to result in disasters. The impacts on people and property can be reduced by mitigating potential

risks and minimizing vulnerability. Natural hazard mitigation can be defined as advanced action that is taken to reduce or eliminate the long-term risk to human life and property from natural hazards. (Godschalk *et al.*, 1999) Long-term mitigation and loss reduction must be the principal goals to protect future generations. This hazards mitigation does not only aim to reduce losses but also to build sustainable local communities and to expand resilience to national and international spheres. (Mileti, 1999)

Mitigation is proactive rather than reactive. Rather than simply waiting for an extreme event and then trying to respond, mitigation planners estimate vulnerability to hazards and take anticipatory actions to lessen risk and exposure. (Godschalk, 2003) (Committee on Disaster Research in the Social Sciences: Future Challenges and Opportunities, 2006) Such actions can be structural or non-structural. An example of structural measures can be strengthening buildings and infrastructures while non-structural can be avoiding new developments in hazardous areas. (Godschalk *et al.*, 1999) Another more specific categorization in mitigation strategies would be:

1. public information (e.g. hazard disclosure, mapping of hazards, education and outreach initiatives),
2. structural property protection (e.g. building and infrastructure hardening, elevation of flood-prone property, levees, seawalls),
3. natural resource protection (e.g. beach, dune and wetlands preservation, riparian buffers) and
4. hazard avoidance (e.g. limiting future development in hazard zones, relocating existing development from hazard zones). (Berke and Smith, 2009)

Today it is well recognised that structural mitigation cannot be the only or primary approach. Negative aspects of such measures include the environmental impact, their high costs, and effects in inducing further exposure of people and property. (Godschalk *et al.*, 1999)

Another approach to overcome disasters is adaptation. *“It usually refers to a process, action or outcome in a system in order for the system (community, region, country...) to better cope with, manage or adjust to changing conditions, stress, hazard, risk or opportunity.”* (Smit and Wandel, 2006) Thus referring to natural hazards it is the ability of a system to adjust to the occurrence of natural hazards to moderate potential damage, to take advantage of opportunities, or to cope with the consequences. (IPCC, 2012)

The mitigation and adaptation concepts in the literature are sometimes overlapping or contradictive, related to the framework that is addressed. When dealing with climate change, mitigation is often related to the reduction of greenhouse gas emissions. (Davidson, 1995) Adaptation is considered more broad, including for example policy-based institutional arrangements, agricultural and land tenure policies; public/private investment in technologies such as building infrastructure, irrigation systems, and large-scale embankments. (Ayers and Huq, 2008) This gives a different perspective than previous definitions of mitigation related to natural hazards.

It can be considered that both adaptation and mitigation are interrelated and in fact can enhance each other. For example in the agricultural sector soil carbon sequestration is a mitigation measure that also protects against changes in climate and enhances adaptation and the sustainability of crop production. It is recommended to give more attention to synergies between mitigation, adaptation and sustainable development rather than focusing separately on the concepts. (Smith, 2009) Mitigation and adaptation are both needed, and are often supportive of each other. Some challenges are recognised concerning the integration of these strategies to make a significant difference in cost avoidance; namely better information, better capacities for analysis and actions and further policymaking. (Wilbanks and Sathaye, 2007) Adaptation and mitigation are part of hazard management; this is explained in §4.3.

Adaptation and mitigation are tools used for creating a sustainable society. “*Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own need*”. (World Commission on Environment and Development, 1987) It reduces the vulnerability of populations to natural disasters while working to reduce poverty, provide jobs and economic opportunity and improve living conditions. (Godschalk *et al.*, 1999) Following quote gives a detailed description of the concept of sustainability: “*In a hypothetically perfectly resilient (or sustainable) world, the structures – social, material, environmental – we create would be so harmonious with respect to the natural world and its limits, so parsimonious in the use of resources, and so respectful towards our fellow beings, that the occurrence of natural hazards would not be the disruptive and destructive force which they are today. This is perhaps the direction we would wish to orient our behaviour. As civilized populations, capable of understanding and change, adaptation represents our ability to innovate in the search for response to hazard. Together, resilience and adaptation constitute complementary strategies for responding to natural hazards.*” (Hogan and Marandola Jr., 2007)

Sustainability mitigation and adaptation policies have the goal to develop resilient communities. Local resiliency with regard to natural hazards means that a locale is able to withstand an extreme natural event without suffering devastating losses, damage, diminished productivity, or quality of life and without a large amount of assistance from outside the community. In particular, a resilient city is a sustainable network of physical systems (constructed and natural environmental components) and human communities (social and institutional components). (Godschalk, 2003)

#### 4.5 Natural hazard and risk assessment

The terms hazard, risk, hazard assessment, risk assessment, risk analysis and other risk management concepts often have different meanings in different publications. (Noson, 2012) For instance hazard assessment is sometimes called hazard evaluation or hazard analysis. (UNDRO, 1991) The terms natural hazard and vulnerability are addressed in §4.1 and §4.2. To understand their relationship with risk, following figure is presented.

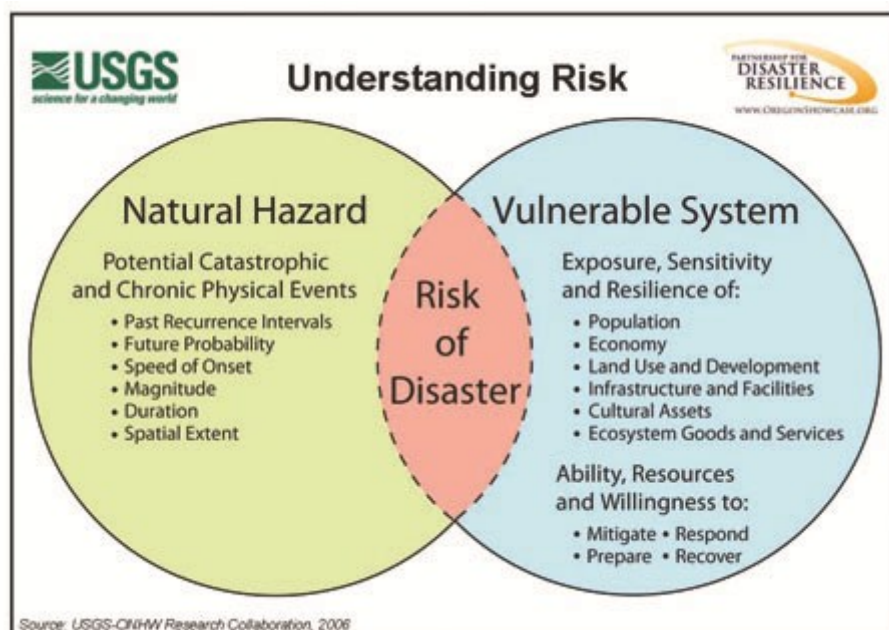


Figure 2: Natural hazard, vulnerability and risk (Oregon Partnership for Disaster Resilience, 2009)

In order to determine the risk, natural hazard assessment and vulnerability assessment must be performed. They are crucial elements of the risk assessment. These terms are further explained in this paragraph.

Hazard assessment can be defined as “*The probability or chance of an event occurring in a particular area based on geological evidence, historical data, and projections derived from theoretical analysis.*” (Noson, 2012) Hazard identification can be considered as a fraction of the hazard assessment and can be defined as the systematic use of all available information to determine what types of disasters may affect a certain area and how often these events can occur. (Whatcom County, 2012) In many documents the hazard identification is merely a list of hazards that are likely to occur in a certain area. FEMA (2001) provides a guideline on how to identify hazards.

Hazard assessment is closely related to scenario building. Scenarios address uncertainties related to natural hazards (inter alia probabilities of occurrence and possible impacts) and aim to improve risk analyses and support decision making. It is in fact a plausible image of a possible future system state. Scenario planning is based on the uncertain predictability of the future. (Mazzorana *et al.*, 2009)

Nelson S.A. (2011) provides a clear understanding on both hazard and risk assessment. This is illustrated in the table below.

**Table 1: Hazard and risk assessment (Nelson, 2011)**

Hazard assessment	Risk assessment
The location and time that natural hazard events have occurred in the past	Hazard assessment
The magnitude of the impacts of these events	The location of buildings, highways and other infrastructure in the areas subject to hazards
The frequency of occurrence of these events	Potential exposure to the physical effects of a hazardous situation
The possible impacts and effects of an event of a given magnitude if it were to occur now	The vulnerability of the community when subjected to the physical effects of the event
Making all this information available to all decision makers in event of a disaster	

From the table it is clear that the hazard assessment is considered a part of the risk assessment. It further contains also a vulnerability assessment and considers the socio-economic impacts of a hazardous event. The total risk can be defined as the probability that an

event will cause x amount of damage, or a statement of the economic impact in monetary terms that an event will cause.

Risk assessment aids decision makers and scientists to compare and evaluate potential hazards and set priorities on what kinds of management is possible. (Nelson, 2011) Determining vulnerability is done by a vulnerability assessment. Many different approaches are used for determining vulnerability. Birkmann J. (2011) investigates 4 different approaches in his research. He considers the goal as to assess the past, current and potential future areas and people at risk or vulnerable. There are several challenges he addresses such as strengthening in cooperation between global and local approaches, more research and transparency about the most vulnerable areas and groups and the integration in a more comprehensive picture. A new methodology for assessing physical vulnerability for multi-hazards is proposed by Kappes M.S. *et al.* (2012). A detailed description on the essential elements for vulnerability analyses is given by Turner II B.L. *et al.* (2003)

Risk assessment can be defined as “*a methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that together could potentially harm exposed people, property, services, livelihoods and the environment on which they depend.*” (UNISDR, 2012) Hazard and vulnerability assessments are crucial elements of the risk assessment.

#### 4.5.1 ***Multi-hazard risk assessment and mapping***

As related to the risk assessment, a closer look is given on multi-hazard risk assessment. It is an extension of the single risk assessments discussed in §4.5.

An increase in more complex risks in Europe is caused by a greater exposure to multi-risk situations. A multi-risk perspective based on the assessment of the territorial vulnerability against multiple sources of hazard is therefore required. (Carpignano *et al.*, 2010) A multi-hazard risk assessment determines the total risk from several hazards. This approach allows dealing with possible cumulative effects and interactions of hazards occurring simultaneously or consecutively. These events can either be coinciding, which means they are dependent of one another or are caused by the same triggering event, or they can be without any chronological coincidence. Such multi-risk approaches are important in all geographic areas susceptible to several types of hazards, as is the case in many regions in the EU. In this

situation, exclusively focussing on the impact of only one specific hazard could even result in raising the vulnerability in respect of another type of hazard. For example, if a building development on a flood plain is approved because its structure includes an elevated and stilted ground floor, this could result in the structure being particularly vulnerable to the effects of earthquake's seismic waves. (EC (2010) SEC 1626 final) A multi-risk approach entails a multi-hazard assessment with a multi-vulnerability perspective. This refers to the variety of exposed sensitive targets for example, population, infrastructure, buildings, etc. that show different types of vulnerability against various hazards and that require different types of capacities to prevent and cope with them. (Carpignano *et al.* 2010) (Mambretti, 2011)

The elaboration of multi-risk maps is an important tool within multi-hazard assessment. This requires a multi-dimensional and coherent approach. These should contribute to the integration of the stakeholders' perception and sustain better governance within a participative decision-making process. The multi-risk maps should not replace but complement existing single risk maps and give a more accurate representation of the complexity of the risks for an area. (Carpignano *et al.* 2010) An example for a proposed methodology for hazard and vulnerability assessments using multi-hazard mapping is given by Tate E. *et al.* (2010)

Multi-risk assessment can provide a complete risk-profile, by addressing all hazards and their possible interconnections. Chapter 5 addresses the multi-hazard approach in the EU.

#### **4.6 Natural hazards and risk management**

Risk management can be defined as *a framework for the systematic application of management policies, procedures and practices to the tasks of identifying, analysing, evaluating, treating and monitoring risk.* (Pearce 2002) Or as *the process of addressing an event that has the potential to seriously disrupt the social fabric of the community.* (McMillan, 1998) Most literature and policies refer to disaster management rather than hazard management. Although hazards and disasters are two very different concepts, the terms of their management is in most cases the same. Both relate to the disaster management cycle (see §4.6.1).

In the United States it can be said that disaster management planning is based on civil defence, natural disaster responses and on behavioural science research. A shifting from



response and recovery towards mitigation is increasing globally. (Pearce, 2003) Prater C.S. and Lindell M.K. (2000) acknowledge as well that attention has turned increasingly to hazard mitigation. Pearce L. (2003) considers a shift in the whole disaster risk management (see Table 2).

**Table 2: Shift in disaster management (Pearce, 2003)**

<b>From</b>		<b>To</b>
Hazards	⇒	vulnerability
Reactive	⇒	proactive
single agency	⇒	partnerships
science driven	⇒	multidisciplinary approach
response management	⇒	risk management
planning for communities	⇒	planning with communities
communicating to communities	⇒	communicating with communities

This shift shows that vulnerability must become the main focus, rather than hazards. Second, the measures must be proactive rather than reactive (response and recovery) (these concepts are explained in §4.6.1) and emphasizing on community planning. Third, a multidisciplinary approach will recognise the many interests that exist in the community and by striving to create partnerships, common goals and interest should be obtained. And fourth, the public should be integrated in the planning process, whereby communities can bring a valuable input in disaster management. (Pearce, 2003)

#### 4.6.1 *Disaster management cycle*

The disaster management cycle consists of four stages: mitigation – preparedness – response – recovery. Mitigation and preparedness are pre-disaster stages (cfr. proactive), while response and recovery are post-disaster stages (cfr. reactive). Mitigation is the only phase that takes place well before the disaster event and includes long term planning. This term is explained in detail in §4.4. Preparedness is focused on short term actions such as evacuation plans and early warning systems. Response is often a matter of civil protection such as evacuation and provision of supplies. *Disaster recovery practices involve the development of plans and procedures, the recruitment and training of staff, and acquisition of facilities, equipment, and materials needed to provide rapid and equitable disaster recovery after an incident no longer poses an imminent threat to health and safety.* (Committee on Disaster Research in the Social

Sciences: Future Challenges and Opportunities, 2006) Figure 3 explains each step more detailed.

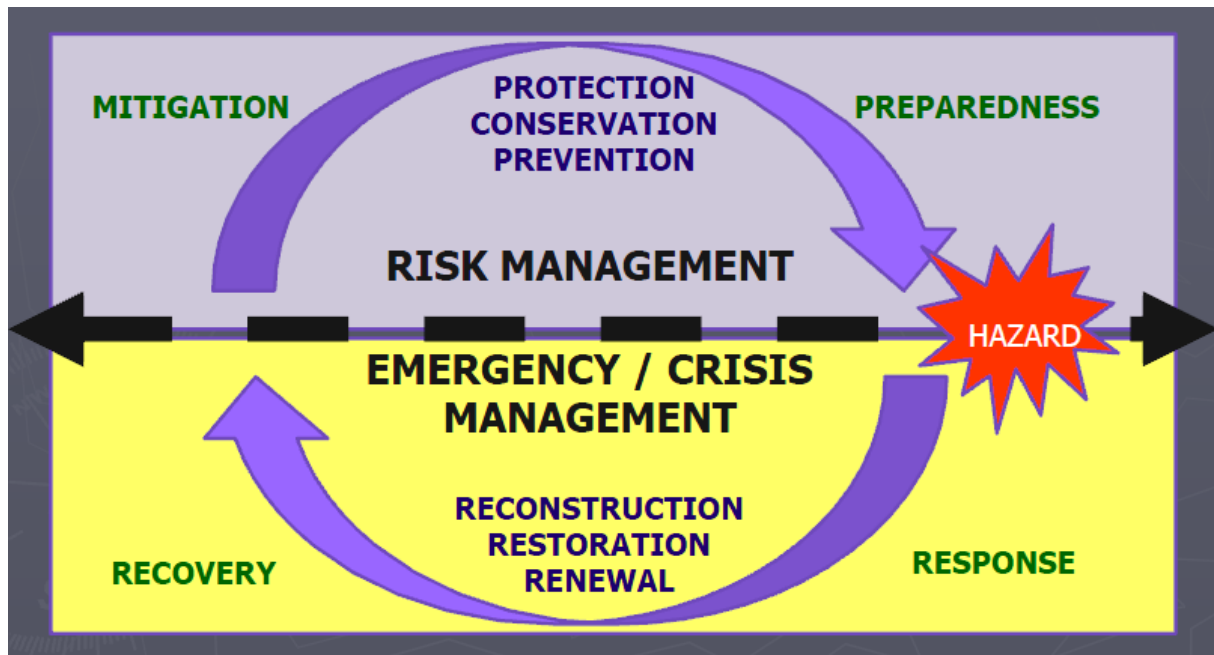


Figure 3: Disaster management cycle (Mileti, 1999)

Past experience with natural hazards contributes to a better understanding of effective disaster risk management and adaptation approaches to manage risks. (IPCC 2012) It is obvious from the figure that the actions of the post-disaster stages are less desirable (economically, socially, psychological...) than the pre-disaster stages. If communities are better prepared and provide a well-established mitigation and adaptation level, the disaster can have a lesser impact and response and recovery can become a smaller burden.

#### 4.6.2 *Integration with ecohydrology*

Decision makers choose certain strategies for the hazard and risk management. It is in the author's opinion that an integration of the ecohydrology concept can be valuable for a multi-hazard management.

Ecohydrology is a complementary new approach with the overall goal defined as enhancement of the ecosystems carrying capacity for ecosystem services and resilience, in particular resilience to anthropogenic stress. (Zalewski *et al.*, 2012) It contributes to a sustainable development and represents a holistic approach which can be adopted in the multi-

hazard framework. It is aimed to address environmental, social and economic vulnerabilities using a multi-hazard mitigation approach in natural hazard management.

Conservative actions have proved to be insufficient in natural hazard management. It is necessary to investigate new approaches, which aim for sustainability and resilience. Mitigation and adaptation are important tools in this process. The ecohydrology approach aims to increase resilience of nature to adapt to human influences. This work focuses on adaptation of human settlements towards natural hazards. Both issues are interrelated by the relationship between nature and human development.

Mainka and McNeely (2011) discuss the integration of environmental considerations in long-term disaster recovery. This recovery on the long-term has the purpose to decrease vulnerability which ultimately also creates mitigation. Ecosystem conservation, carrying capacity and maintaining biodiversity are key concepts. Further an idea is given on policy support and disaster management approaches using ecosystem services and environmental management. Many of the suggestions and ideas of Mainka and McNeely are related to the ecohydrology approach.

Ecohydrology addresses in particular flood hazards. Flood risk is a serious threat and in order to avoid flood disasters, policies and actions are implemented. Compared to other hazards, there is a strong policy program in the EU related to floods (see chapter 7) in particular the EU Flood Directive is a crucial asset in hazard management. This Directive could bring a considerable input in a multi-hazard framework. In such a framework all relevant hazards need to be considered. The ecohydrology approach contains several key concepts which are adopted in the proposal of a new conceptual multi-hazard framework in chapter 9.

#### **4.7 Policy implementation**

Although a top-down policy is needed, it is really the local-level bottom-up policy that provides the impulse for the implementation of mitigation strategies and a successful disaster management process. (Pearce, 2003) The local level of government can be considered as the key to successful hazard mitigation policy. (Prater and Lindell, 2000)

For a successful hazard mitigation strategy governments must have the political will and budgetary commitment to implement plans. (Armstrong, 2002) Local governments are often reluctant to adopt risk reduction policies. Three principal reasons are provided by Prater and Lindell (2000):

- The risks tend to be discounted by the residents and local government, unless there was a recent experience of disaster.
- Other problems such as crime, poverty, education absorb more attention, time and money.
- Hazard-prone areas are often desired places for real estate development. As development increases, mitigation actions become more difficult and costly.

It is crucial to complement the policies with public awareness and education, including public participation. Furthermore, the implementation strategy must not only demonstrate the need for participation from diverse parts of an organization/community, but it must also demonstrate that it complements the work being pursued by those. A key issue to interact with economic development is showing that hazard mitigation measures can be economically viable. (Armstrong, 2002)

Not only the adoption of policy can bring complications but also policy implementation. Prater C.S. and Lindell M.K. discuss the hazard mitigation policy as a major political challenge addressing several political issues. Alesch D.J. *et al.* (2011) studied the shortfalls in the implementation of risk-reduction policy with California as study area.

A strong influence in the policy framework comes from the Hyogo Global Framework, addressed in the following paragraph.

#### **4.8 Hyogo Global Framework**

One of the most influential global frameworks in Europe is the Hyogo Global Framework. Several policies are developed in cooperation with this framework and therefore it is important to review the content and objectives of the framework including the implementation in European case. The Hyogo Global Framework was adopted at the World Conference on Disaster Reduction in Japan in 2005. The framework contains most relevant and present global issues in hazard management that have to be tackled by 2015. (ISDR 2005)

The Hyogo Framework for Action (HFA) is a ten year global plan which promotes a strategic and systematic approach for reducing vulnerabilities and risks to hazards by building the resilience of nations and communities. The framework has adopted 5 priorities for action:

1. Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation.
2. Identify, assess and monitor disaster risks and enhance early warning.
3. Use knowledge, innovation and education to build a culture of safety and resilience at all levels.
4. Reduce the underlying risk factors.
5. Strengthen disaster preparedness for effective response at all levels.

With these priorities for action the framework wants to achieve an effective integration of disaster risk considerations into sustainable development policies, planning and programming at all levels, with a special emphasis on disaster prevention, mitigation, preparedness and vulnerability reduction. Secondly it aims to strengthen and develop institutions, mechanisms and capacities at all levels, in particular at the community level, which can systematically contribute to building resilience to hazards. The last goal is the systematic incorporation of risk reduction approaches into the design and implementation of emergency preparedness, response and recovery programmes in the reconstruction of affected communities. (ISDR 2005)

#### **4.9 Conclusions**

Disasters caused by natural hazards are increasing worldwide, probably influenced by climate change but more important due to an increase in vulnerability as a result of dynamics and patterns of present settlements. Different actors (economic, social, demographic, locational, etc.) have increased vulnerability in societies and have put in particular urban areas at high risk for natural hazards.

It is necessary to deal with these issues rather than rely on response and recovery after a disaster has occurred. For doing so pro-active measures must be taken. Mitigation and adaptation are strategies part of hazard management which encounter such pro-active actions. Before taking actions a risk assessment must be carried out, including a hazard assessment (or hazard identification), and scenarios must be build up. Such assessment is only complete if a multi-hazard approach is adopted. (Carpignano *et al.* 2010) For single risk assessments ignore several risks originated by several hazards occurring simultaneously or consecutive.

A holistic approach is adopted and economic, environmental and social objectives must be all considered. This is only possible by achieving sustainable solutions. Communities must become more resilient and adaptive.

Policies must help obtain the desired objectives by improving implementation of mitigation and adaptation measures. All levels are crucial in this process: European, national, regional and local. They must cooperate and assist each other in order to obtain adequate results. Further this research will focus on the current situation in the EU and its policy framework.

## **5 Assessment of multi-hazard approaches in the EU**

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The EU and its MS have been assigned as application area for this research. First an introduction is given in natural hazards in Europe. Following there is a review on current multi-hazard approaches in risk assessment and management which explains current situations and challenges. Next a link is made with spatial planning tools. The chapter concludes with answering the question why common strategies in the EU are beneficial.

In order to investigate the current multi-hazard approaches in the EU, this research uses several studies from EU projects. These specific projects are directly related to risk assessment and/or risk management of natural hazards. There are many more projects and studies on different levels conducted in the EU however this selection gives a clear understanding on current practices and possible challenges. They are selected according to their relevance and influence. The official EU guidelines have a stronger and broader application than guidelines performed on smaller scales. A similar approach is used for the projects e.g. the ARMONIA project is funded under the Sixth EU Framework Programme for Research and Technological Development.

### **5.1 Natural hazards in Europe**

The number and impacts of disasters have increased in Europe, between 1998 and 2009 natural hazards caused a loss of about 200 billion EUR in Europe. Events with the highest human losses were the heat wave of 2003 over western and southern Europe, with more than 70 000 fatalities, and the Izmit (Turkey) earthquake of 1999, with more than 17 000 fatalities. (EEA 2010) Other hazards that led to disasters are storms, extreme temperatures events, forest fires, water scarcity and droughts, floods, avalanches, landslides and volcanic eruptions. Global and country based maps and graphs can be found on the EMDAT (2012) website. About 90 % of the events and 80 % of the economic losses from disasters due to natural hazards that occurred in Europe since 1980 were caused by hydro meteorological or climatological hazards. Nevertheless, large earthquakes can still occur in specific areas in Europe, albeit relatively rarely, and such events could generate huge losses, since the assets at risk are of considerable value. The increase in losses can be explained to a large extent by higher levels of human activity and accumulation of economic assets in hazard-prone areas. (EEA 2010)

Risk profiles of the MS vary considerably depending upon their proneness to hazards, the vulnerability of infrastructure and constructions, the size of the economies, and the level of concentration of economic activities in disaster-prone areas. By comparing the potential losses of disasters caused by natural hazards with a 250 year return period, it becomes clear that there is a higher level of vulnerability among smaller-size economies (see Figure 4). (Gurenko and Zakout, 2008)

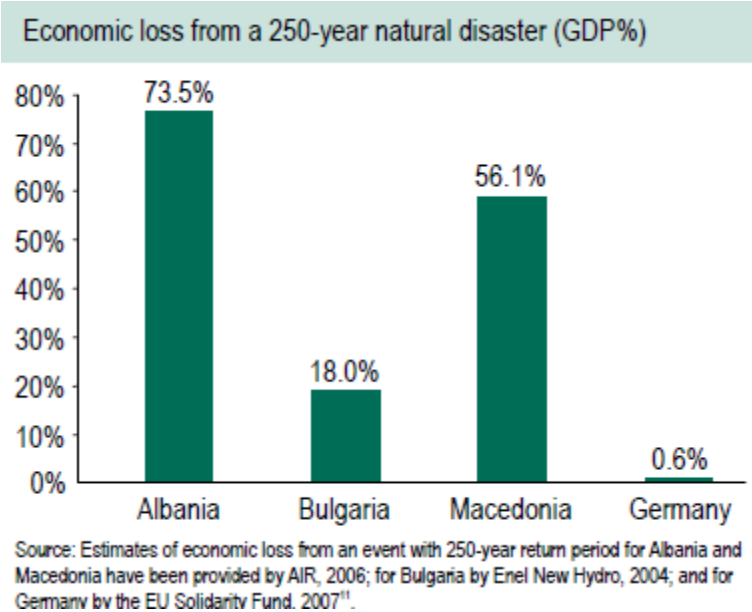


Figure 4: EU exposure to natural hazards (Gurenko and Zakout, 2008)

It is clear that the increase of disasters is a concern for the EU and higher efforts are necessary; even more for smaller-size economies. By addressing vulnerability the amount of disasters can be decreased. This is only possible by using efficient multi-risk assessment and management. These concepts related to the EU are explained in the following paragraph.

**5.2 Multi-risk assessment and mapping**

There are several guidelines and many projects established in the EU. Only a few are presented here; in the author’s opinion they are of the most relevant and influential in the EU: the project Natural Risk Assessment, a working paper “Risk assessment and mapping guidelines for disaster management” and the ARMONIA project.

It is acknowledged that disaster risk assessment and risk management are essential inputs for planning and policies. EU legislation has introduced some "single-hazard" risk assessment



requirements for natural hazards however only flood risk and drought have been fully addressed. (EC (2010) SEC 1626 final) As risk potentials are increasing, cumulative effects and interactions between different hazards should not be neglected. However, in most EU-countries a multi-hazard approach hardly or doesn't exist because of the diverse responsibilities of sectorial planning divisions for different natural hazards. (Greiving *et al.*, 2006)

The report "Principles of multi-risk assessment" reflects the main outcomes of the European project Natural Risk Assessment (Na.R.As.). A description of best practices in single hazard risk assessment regarding seismic, volcanic and hydrogeological hazards in the EU is given. Concerns about these single-hazard strategies imply the difficulties of comparing risks of different origins and ignoring possible interactions among threats and/or cascade effects of single hazards. This means that a potential 'multi-risk' could be higher than accounting only on the single risks. Multi-risk approaches are the basis for developing a sustainable environment and land use planning as well as for a competent emergency management before and during catastrophic events.

The report aims to help clarifying the key ideas around the concepts of multi-risk applied in the EU. A new quantitative procedure is presented for multi-risk assessment that makes easier the comparison among different threats and accounts for possible triggering effects. The procedure is as following: (Marzocchi *et al.*, 2009)

1. Identification of hazards/risks sources.
  - a. Risk sources identification (nature, location and management issues).
  - b. Characterization of adverse events and its propagation path.
  - c. Definition of possible single and multi-hazard scenarios starting by a given top event and evaluating the possible triggering of other events.
2. Exposure and Vulnerability analysis.
  - a. Definition of exposure.
  - b. Phenomenon intensity distribution (e.g. ground acceleration, pressure waves, distribution of chemical substance concentration for various areas, thermal flow, etc.).
  - c. Identification of vulnerable elements (population at risk, strategic infrastructures, lifelines, historical structures, buildings, etc.).

3. Risk estimation.
  - a. Definition of the type of damage (e.g. reversible/irreversible damage to humans; lethality; reversible/irreversible damage to the environment, damages to structures, infrastructures, lifelines, economic damages, etc.).
  - b. Estimate of the entity of damage.
  - c. Probabilistic estimate of risk of each adverse event and of multi-risk.
  - d. Comparison between the multi-risk value and the “acceptable risk”.

A more detailed description of the steps is explained in the document. The study gives a rank of possible risks using classical risk approaches. This led to an understanding of which hazards lead to the highest single risk. Further a series-parallel cascade scenario is explored which show that some risks are underestimated if the interaction among them is ignored. A case study is used to apply the presented procedure for multi-risk assessment. (Marzocchi *et al.*, 2009)

Some difficulties regarding multi-risk are acknowledged. The first is that scientists of various disciplines do not use a common terminology. In some cases scientists dealing with different types of environmental risks assign different definitions even to the same term. Other difficulties are mostly due to different practices (qualitative and quantitative) and spatial and temporal resolutions that make hard the comparison among different risks.

A final consideration is on the meaning of multi-risk for planning mitigation actions. It is argued that mitigation actions have to be focused not necessarily on reducing the highest rank risk. A rational mitigation policy has to focus on the risks that could be mostly reduced. In other words, it is not rational to spend all the money to reduce of 0.1% the highest risk, when with the same amount of money significant percentages of all others can be reduced. It is argued that mitigation actions have to be decided considering the multi-risk assessment together with a sound cost/benefit analysis. (Marzocchi *et al.*, 2009)

A guideline on risk assessment and mapping was established in 2010 within the context of the communication on prevention of natural disasters (see §7.3.3). The main purpose of it is to improve coherence and consistency among the risk assessments undertaken in the MS at national level in the prevention, preparedness and planning stages and to make these risk assessments more comparable. The guideline is built on experience in the practical implementations of national risk assessments and mapping, in particular existing good practice risk assessments. They are based on a multi-hazard and multi-risk approach.

The EU legislation holds only a few examples that include the use of single hazard risk assessments: the Flood Directive (FD), the Water Framework Directive (WFD) and the European Critical Infrastructures Directive (see chapter 7). It is the purpose of this guideline to complement these policies.

The risk assessment process has according to the guideline 3 important elements: actors, public consultation and communication and data. A conceptual framework and basic methodology is written down. In this methodology it is explained how to include vulnerability in the risk assessment process. By using the concept of vulnerability, it is emphasized that the impacts of a hazard are also a function of the preventive and preparatory measures. Those impacts can be: human, economic, environmental and political/social. The multi-risk assessments take into account possible hazard and vulnerability interactions. The important elements of vulnerability analysis is given, however there is no actual method provided. It is also recommended for national risk analyses to strive to consider both single-risk and some multi-risk scenarios and carried out per category of impact. A multi-risk approach entails a multi-hazard and a multi-vulnerability perspective. The multi-vulnerability perspective refers to the variety of exposed sensitive targets, for example, population, transport systems and infrastructure, buildings, cultural heritage, etc. that show different types of vulnerability against the various hazards and that require different types of capacities to prevent and cope with them. The use of scenarios is recommended.

The final step is risk evaluation that uses risk criteria to compare with the results of the risk analysis. They can include costs and benefits, legal requirements, socioeconomic and environmental factors, concerns of stakeholders, etc. An issue is how to set these criteria, and who will be responsible for doing that. The FD requires MS to set their own flood risk management objectives, given that situation differs from catchment to catchment or even location to location. Another approach is used in the Eurocodes, which gives specific prevention standards such as building codes. The guideline encourages more transparency in this area. Recommendations on thresholds and quantifications are presented.

A future version of the guideline will contain a catalogue of recommended methods and standards for risk assessments. The current version is limited to a general explanation on risk assessment, divided in 3 stages: risk identification, risk analysis and risk evaluation. (EC (2010) SEC 1626 final)

Risk maps generate a level of transparency which can help engage all interested actors in society. (EC (2010) SEC 1626 final) A brief overview and recommendations on existing

strategies in risk mapping is given in the guideline on risk assessment and mapping. There are numerous examples of hazard, vulnerability and risk mapping methodologies being used by public authorities and private organisations in Europe and the wider world. The guideline states that a recognised challenge would be the lack of qualitative aspects of vulnerability and risk perceptions. A step by step approach is proposed to be taken in the MS to develop risk maps which contains: maps showing the expected spatial distribution of major hazards where hazards and intensities shown, maps showing spatial distribution of all relevant elements to be protected (e.g. population, infrastructures) and maps showing the spatial distribution of vulnerability in terms of susceptibility to damage for all relevant subjects of protection. These maps can provide the basis for the preparation of risk maps in terms of showing combination of likelihood and impact of a certain event as well as for aggregated hazard maps. (EC (2010) SEC 1626 final)

The ARMONIA (Assessing and mapping multiple risks for spatial planning) project was financed under the Sixth EU Framework Programme for Research and Technological Development and ran from October 2004 to March 2007. The overall aim of this research project was to develop a new approach to produce integrated multi- risk maps to achieve more effective spatial planning procedures in areas prone to natural disasters in Europe. Important conclusions from the document are:

- With a few exceptions a multi-risk approach is not used in Europe.
- Due to increased attention for hazards after recent disasters, risk assessment and management focuses more on frequent hazards. They underestimate the risk from extreme events.
- Little attention is paid to vulnerability.
- Spatial planning presently plays only a minor role in the risk management:

After analysing the current practices of risk mapping in Europe it is concluded that there are a range of different practices in hazard, vulnerability and risk mapping across the hazards in the EU.

The research aims to define a new harmonised methodology for integrated management of data from different risk analysis approaches and to set-up basic principles for an EU directive on integrated risk mapping aiming specifically at spatial planning. In a first step a differentiated approach on the assessment of multiple vulnerabilities is described. Different annexes can be downloaded with this report; one in particular deals with harmonised hazard,

vulnerability and risk assessment methods related to mitigation strategies and addressing land-use planning and management. The research also produced a framework and decision support tool structure for risk informed planning. This is called as the Multi Risk Land Use Management Support System. It aims to help ensure that planning decisions are fully informed about the multiple risks affecting particular areas of land, the vulnerability of different land uses and populations (taking account of main social factors) and the options that are available to mitigate the risks. With the use of multi-scale, multi-risk and multi-vulnerability characteristics it enables to run different scenarios.

Next, a complementation is proposed of the Strategic Environmental Assessment (SEA) with the decision support system considering both systems go through similar stages: initiation, preliminary analysis, risk estimation, risk evaluation, risk management and monitoring. It must be mentioned that the SEA Directive does not include any connection to natural hazards. However this research sees an opportunity given that SEA is indispensable for reaching the political goals of EU environmental policy. Therefore it should be useful to emphasise the potential role to planning practitioners.

The ARMONIA methodology is investigated in several case studies. Results are presented in the report. It is concluded that further research is required to improve the methodology *inter alia* what the end users of risk maps actually require.

Finally it is proposed to conduct a directive on the implementation of multi-risk analysis into land use planning and management for the reduction of natural disasters. This directive would have to lay down a framework for the reduction of risk to human health, the environment and economic activity associated with natural hazards vs. land use planning and management in the EU. (ARMONIA, 2007)

### **5.3 Multi-risk management**

It is acknowledged that in recent years, policies for disaster risk reduction and management have shifted from defence against hazards (mostly by structural measures) to a more comprehensive, integrated risk approach. (EEA, 2010) However reports indicate there is still a need for more comprehensive approaches that require a cross-cutting thinking and integration with sectors such as environment, sustainable development, energy, etc. (EC DG Environment, 2008a)

The growing vulnerability of our society and changing environmental conditions in the EU aggravate the risk related to particular natural hazards. For these reasons, disaster management has to be integrated into other initiatives including sustainable resource planning (in particular, land-use planning), the development of adaptation and mitigations strategies to address climate change and its consequences, and more generally, policies and research initiatives to increase the resilience of citizens and communities. (EEA, 2010) The integration of prevention actions with spatial planning and risk mapping is generally appreciated in the MS, and is taken into national legislation. However, there seems a big challenge in enforcement and control. The need to have Europe-wide monitoring capacities is therefore well recognised. (EC DG Environment, 2008a)

An emphasize lies also on the synergies between disaster risk reduction and adaptation actions to climate change. A number of countries have developed national climate change adaptation strategies, which are already linked and coordinated with national strategies and platforms for disaster risk reduction, although these ties could be further enhanced. (EEA, 2010)

It is essential to consider all phases: mitigation – preparedness – response –recovery (see §4.6.1) and to take into account and consequently maintain all measures (e.g. spatial planning; technical measures). Furthermore, effective risk management relies on the involvement of all potential stakeholders, from national, regional and local administrations to the scientific community, the private sector (e.g. insurance companies) and citizens. Every stakeholder should contribute to measures and activities according to their own capacities and skills, and should be empowered to do so (e.g. by education and awareness raising). (EEA, 2010) Many countries still lack the integration of the private sector and neglect possible benefits this could bring. Another issue is that each country is working on different levels and scales including the involvement of local levels. It is recommendable to achieve common approaches. (EC DG Environment, 2008a)

The EU has a set of policies (see chapter 7) and made efforts on developing EU guidelines on risk assessment and mapping for disaster management. At a national level, one major activity has been the establishment of national strategies and national platforms for disaster risk reduction. National Platforms are multi-stakeholder national mechanisms for disaster risk reduction at different levels: from communities to the national institutions. (EEA, 2010)

In 2010 an inventory was published on existing sources of information related to disasters natural hazards and technological accidents for the period of 1998-2009 at European level. The report discusses the occurrence and impacts of disasters and underlying hazards. Further it brings for all natural hazards a list of events and a case study in detail. Current management options are explained with measures and policies available and sometimes recommendations to improve them. Also, for all hazards a brief summary on data gaps and information needs are given. (EEA, 2010)

From the 4 recognised phases in hazard or risk management (mitigation – preparedness – response –recovery) this research work focuses on the mitigation phase. A brief overview of them is given in §4.6.1. The next paragraph addresses the mitigation phase applied in the EU.

### 5.3.1 *Disaster prevention - mitigation*

Many documents talk about disaster prevention, rather than mitigation and adaptation. However in most cases they mean the same or have the same objectives. Prevention can be defined as requiring a multi-hazard approach which involves several dimensions of integration and implementation in order to reduce vulnerability: (EC DG Environment, 2008b)

- horizontal integration of prevention into EU policies, financial instruments and funds;
- sector-specific (vertical) integration of existing EU policies and legislation which have preventive elements;
- integration of land use requirements, spatial planning, etc. at national, local as well as EU levels (scale dimension) where relevant.

Prevention, adaptation, mitigation and preparedness, and the linkages between the four, are the areas in which MS and the EU have to perform effectively to achieve environmental and social desired standards. The biggest gap is the absence of an overall integrated approach on the prevention. On top of this, preventive steps should be better integrated in all existing EU instruments. (EC DG Environment, 2008b) Successful implementation of prevention policies depends on the strengths and resources available in a country. Even if all is available there might still be barriers to overcome in order to get all actors and resources into play. The main drivers for policy framing in the MS are external policy requirements, such as the FD and the WFD. They do not only lead towards a more integrated approach but also lift standards on

specific issues. Besides these legal requirements international obligations and efforts concerning climate change have brought adaptation stronger recognition in the need for comprehensive approaches to disaster prevention and to structures, processes and policies. It is recommended for the EU to stimulate the political focus in MS by inter alia yearly reports. Most MS seem to have included risk and vulnerability assessments. However there is a need for cross-cutting national vulnerability assessments and development of scenarios covering the union and then scaled down for each MS to local and regional levels into measures relevant for each sector. (EC DG Environment, 2008a)

There are indications that prevention is mostly appreciated after an experienced disaster. The focus then lays on that particular disaster. Furthermore, at individual level, a loss of sense of responsibility towards prevention is observed. People tend to rely more on the authorities to protect them sufficiently. An example related to the insurance system, is given in the report: “In France, the system is legally founded; solidarity based; joining the insurance is compulsory; and the system is managed by the insurance sector and guaranteed by the State. This implies that all property owners are covered no matter their financial situation. The advantage of this system is the overall high level of security; and its automatic inclusion also of the less well-off parts of the population. The latter implies that there is no income-related bias. The drawback is its potential lack of incentives for individual pro-active behaviour in regard to prevention, and the possible lack of incentives also for the insurance sector to incite prevention behaviours.” Incentives for better prevention behaviour and attention could be provided through awareness building and educational efforts. (EC DG Environment, 2008a) It is suggested to create a framework which sets a strategic approach for vulnerability assessment and reduction and to strengthen existing EU legal and policy framework.

It is further advised to address economic return to potential disaster risk reduction (cost-benefit analyses). Research has shown that investments in prevention can actually generate high economic returns. There should also be a focus on lessons learnt, not only in the EU; inter alia Japan has advanced multi-hazard approaches to prevention. Frameworks such as the Hyogo Framework for Action (see §4.6) can provide useful information. (EC DG Environment, 2008b)

The document “Member States' Approaches towards Prevention Policy” gives a critical analysis on the approaches to disaster prevention in the MS and provides conclusions and recommendations as regards the scope of a possible EU comprehensive intervention in the



field of disaster prevention. A desk study is followed by 4 case studies in the EU and a framework is presented for analysing the weaknesses, strengths and challenges at Member State level. It is investigated to what extent improvements can and will be provided and to what extent an EU intervention can assist in facilitating or accelerating the process. The report recommends more comprehensive strategies, a stronger link between crisis management/civil protection and disaster prevention, integration of prevention into spatial planning, and improving cross-border issues. (EC DG Environment, 2008a)

The study “Assessing the Potential for a Comprehensive Community Strategy for the prevention of Natural and Manmade Disasters” can be considered a prolongation of the research “Member States' Approaches towards Prevention Policy”. The purpose is to provide the Commission with a critical analysis and recommendations which will enable to:

- assess the need and potential added-value of a comprehensive Community multi-hazard strategy on disaster prevention within the EU,
- identify the potential basic requirements of such a strategy and
- suggest possible policy options.

The current EU settings are discussed by identifying approaches and challenges in the existing EU framework. The strengths and weaknesses of different EU policies are illustrated in the report. There are sector specific instruments (e.g. Flood Directive), thematic approaches (e.g. land use and spatial planning) and comprehensive approaches (e.g. Directive on European critical infrastructures). (EC DG Environment, 2008b)

Case studies are performed on the Green Paper on Adaptation (concerns climate change), the EU Flood Directive and the Seveso Directive (manmade hazards). An important asset related to the Green Paper on Adaptation is that it provides cross-cutting programmes and issues and supports the integration of prevention in other relevant EU policies and sectors. Further an action program is presented linking the roles of each authority level (the MS, regional, local and the EU). Unfortunately the Green paper does not address all natural hazards or the multi-hazard approach. The EU Flood Directive is considered to have a flexible approach to risk prevention and can be recommended for a wider applicability. More on the EU Flood Directive is presented in §7.2.2. The Seveso Directive provides an overall framework addressing manmade hazards. It provides important linkages to land use and spatial planning. It is also recommended for the approach to extend to the natural hazard policies. (EC DG Environment, 2008b)

A comprehensive approach is recommended as it would consider all themes within the same framework, involving both thematic and sector based considerations and actors. Improvements could be made on existing sector and thematic measures, on which the EU could take timely action as part of an overall prevention effort. A multi-hazard approach on natural hazards is considered to be more efficient and effective in e.g. climate change and a legally binding initiative is preferred rather than a guideline. Existing Community policies and measures should be taken into account; an initiative should be complementary to existing efforts. (EC DG Environment, 2008b)

These conclusions lead to a three-pillar approach to the EU's future effort on prevention.

1. Strengthening prevention in existing EU mechanisms and MS approaches
2. Developing a new framework approach on disaster prevention
3. Supporting further development of prevention knowledge and technology through EU research and development programs. (EC DG Environment, 2008b)

An outline of a draft EU framework directive on prevention is given. A stepwise approach is recommended for the proposed framework, which seems quite similar with the approach in the Flood Directive. The research gives a clear and overall recommendation on how the EU should apply its strategy in the near future. (EC DG Environment, 2008b)

A report is made to identify key trends in terms of progress made and challenges faced at both national and regional levels through the implementation of the Hyogo Framework for Action (see §4.8) in Europe between 2009 and 2011. While in some countries consultation exercises were conducted as part of the review process, the reports are self-assessments by national authorities. (UNISDR EUR *et al.*, 2011)

On national level the strategic goal statements illustrate the ways in which countries are moving from a culture of reactive response and recovery from disasters to proactive risk reduction and safety. This requires a significant change from a mind-set of crisis to one of resilience. However many challenges remain to enclose a resilience culture in policies, programs and planning. All five priorities for action from the HFA, mentioned in §4.8, are investigated and commented. Recognised in the report it remains a challenge in the EU: (UNISDR EUR *et al.*, 2011)

- To implement disaster risk reduction in policies and legal frameworks, more specific to coordinate across different levels and dealing with the cross-cutting nature of it.
- To address a broad range of risks and hazards in a single framework. Disaster management is a cross-sector activity, and one of the key challenges in the future will be to improve cooperation among different ministries, government agencies, institutes and public services.
- To address risk assessment at local levels and to expand the use of research methods and tools for multi-risk assessments.
- To show the cost effectiveness of efforts for investment in risk assessment to become sustainable.
- To sustain funding for multi-hazard tools and motivation by return of investment has not been conclusively demonstrated.
- To integrate vulnerability assessments. Critical facilities such as hospitals and schools need to be addressed, risk assessments have to be performed and procedures established to assure the protection of those facilities and their users. A common understanding needs to be established of appraisal of impacts. Physical damage is easy to measure, but other losses such as loss in biodiversity, environmental risks or social and cultural risks are more difficult. Experts from a range of professions are needed for the assessment on such vulnerability issues. Another challenge concerned with vulnerability assessment is to collect data from the private sector, as they often are reluctant of giving information for fear of revealing areas of vulnerability.
- To raise public awareness as many people believe that it is the responsibility of civil authorities to take care of them in the event of an emergency and so they make little effort to provision for themselves. Building owners underestimate the risks and often neglect or postpone rehabilitating the structures.
- To institutionalize procedures to integrate disaster risk reduction measures into national sustainable development strategies, plans and programmes in key areas such as poverty, reduction, housing, water, sanitation, energy, health, agriculture, infrastructure and environment to ensure that development does not create further disasters. When environmental and natural resource policies specifically incorporate disaster risk reduction elements, they can help to reduce underlying risk factors.
- To include disaster-risk reduction elements in land-use plans as it is an important strategy for reducing the vulnerability of communities to hazards. Land-use planning

that is carefully designed and rigorously implemented is a useful approach to manage expanding human settlements and minimize associated risks.

- To conduct a rigorous financial analysis demonstrating the positive return on investments. The biggest challenge identified by countries is that immediate economic constraints outweigh longer-term safety concerns. Financial resource limitation can be a severe hindrance; particularly at local levels there are difficulties to meet the demands for services and operations.
- To collect and retrieve data. Although substantial progress has been made in gathering risk and hazard data, a physical problem needs to be encountered related to the amount of data. Knowledge management is essential as data sets grow in complexity. The task is more than collecting data; it is necessary to make sure that the information can be identified, retrieved and used in an effective and efficient manner. A large amount of information is already available and on-line tools and databases have been created, although it is not yet clear that there is a common understanding of these tools among all of the stakeholders.
- To engage all the stakeholders in local disaster risk reduction activities. A multi-stakeholder risk analysis limits the risk of making analyses to single groups, such as civil authorities with responsibility for emergency response.

A significant progress is acknowledged concerning regional and trans-boundary cooperation. Especially the EU Flood Directive has encouraged taking such initiatives. Weather forecasting and monitoring has shown improved capacity through international cooperation. The European Union Flood Directive has harmonized certain risk management practices. Flood risks are on top of mind in disaster reduction while less familiar risks receive lower priorities in cooperative efforts. Efforts aimed at enhancing regional cooperation on risk reduction are assuming increasing importance. (UNISDR EUR *et al.*, 2011)

To conclude this paragraph on disaster prevention – mitigation also the project ‘Mitigating spatial relevant risks in European regions and towns’ (MISRAR) should be mentioned. This project involves 6 EU MS. A first brochure is available on the website providing information related to risk assessment and mitigation. But more important a handbook is being prepared by the participants concerning risk assessment and mitigation planning. This handbook is planned for October 2012 and could be an asset for the EU guidelines proposed in chapter 9. (MISRAR, 2012)

#### **5.4 (Inter)national policies into local spatial planning tools**

Little attention is paid to spatial planning in hazard mitigation in European legislation. Only for technological hazards, this is briefly mentioned in the Council Directive 96/82/EC (SEVESO II). A research on spatial planning and risk assessment in several EU MS shows large varieties among them, and even within some MS, related to regional planning. It is observed that an integrated planning approach is mostly missing; spatial planning plays only a minor role in risk management and vice versa. Furthermore, regional or national risk management policies, programmes and measures fail in most cases because local level authorities often do not follow these. (Greiving *et al.*, 2006) One way to resolve this policy implementation dilemma is to include mitigation planning in the more commonly used land use planning process, and to design hazard mitigation strategies that also achieve other community goals, such as protection of natural resources and provision of recreation areas and open spaces. (Burby, 1998)

While mitigation against hazards ultimately requires local action, it is important to acknowledge that local action typically occurs in an intergovernmental framework of national policies and programs aimed at empowering and motivating local governments to build mitigation into their plans and actions. (Burby, 1998) Therefore the different levels of authority – local, regional, national and international – need to promote cooperation between them in order to complement each other's activities to ensure sustainable and equitable urban development. (El-Masri and Tipple, 2002)

#### **5.5 Why common strategies on EU level?**

From experience of various hazards a good cooperation at European level is beneficial for reducing the risk of disasters. Some of the benefits of a strategy at EU level are summarised in this paragraph. (EEA 2010)

As hazards can occur across national borders, a trans-boundary strategy will provide a more efficient and effective risk management approach. A good cooperation at a technical level, such as the development of common guidelines or methods can contribute to an improved integrated risk management through Europe. For example, the impact of technological hazards has declined since 2003 due to the implementation of the EU legislation. (EEA 2010) The EU can play an important role in capacity building in disaster prevention. Sharing expertise, combining resources and exchange of best practices are some of the strengths of an EU integrated strategy. The EU could be a main driver for the application of a multi-risk

approach and take a leading role in investing in research and development. (EEA 2010) It could result for example in databases of thematic experts available for consulting on specific problems.

Although most MS possess a good spatial data infrastructure, the need to establish European-wide monitoring capacities is well recognised. Monitoring the MS would help to support a stable political focus on disaster prevention. (EC (2010) SEC 1626 final)

## 5.6 Conclusions

Chapter 5 reviews current approaches and challenges in the EU by consulting several research projects. It also presents some guidelines, tools and procedures available for future use.

*With a few exceptions, EU countries do not use a multi-hazard approach. France, Greece and Italy are a few exceptions where it has been partly integrated in the assessment of natural hazards.* (Greiving *et al.*, 2006) This means in many cases potential risks are neglected. A multi-risk approach entails a multi-hazard and multi-vulnerability perspective. Mitigation actions should consider a multi-risk assessment. A new quantitative procedure of multi-risk assessment is presented in the report “Principles of multi-risk assessment”. A future version of the guideline “Risk assessment and mapping guidelines for disaster management” will contain a catalogue of recommended methods and standards for risk assessment and risk maps.

*Current approaches are very much based on recent disasters, with other risks remaining underestimated.* (ARMONIA, 2007) *Furthermore a loss of sense of responsibility is seen on individual level.* (EC DG Environment, 2008a) Awareness building and educational efforts can make people more aware and prepared.

There is also not enough attention put on vulnerability and spatial planning in risk management. *There is a need for cross-cutting national vulnerability assessments and development of scenarios covering the EU and then scaled down for national and local circumstances into measures for each sector.* (EC DG Environment, 2008a) *Spatial planning can be a useful approach to manage expanding human settlements and to minimize associated risks.* (UNISDR EUR *et al.*, 2011) Mitigation and adaptation planning and spatial planning should become more integrated.

A new methodology on integrated risk mapping aiming specifically at spatial planning is presented in the project “Assessing and mapping multiple risks for spatial planning

approaches, methodologies and tools in Europe”. This project also produced a framework and decision support tool structure for risk informed planning.

There is still a big challenge for acquiring comprehensive approaches with sectors such as environment, energy, land use planning, sustainable development, etc. integrated in hazard management. *Sometimes the integrations are acknowledged but difficulties arise in enforcement and control. A monitoring function for the EU would be beneficial. Many countries also lack an integration of the private sector and therefore miss opportunities.* (EC DG Environment, 2008a)

*The absence of an overall integrated approach on prevention remains a big challenge. Such approach has to integrate preventive steps in all existing EU instruments.* (EC DG Environment, 2008b) *It is recognised that the main drivers for policy framing in a MS are external policy requirement such as the Flood Directive and Water Framework Directive. They lead to a more integrated approach and also lift the standards on specific issues. Also awareness on climate change is an important drive.* (EC DG Environment, 2008a) A link should be made towards climate change adaptation. Such strategies are numerous and can be enhanced by relating to hazard management.

*Economic return is a field that still needs to be more explored. Cost effectiveness and cost-benefit analyses are important tools for this.* (EC DG Environment, 2008b) It can be a strong argument for improving implementation of mitigation and adaptation measures.

*Good cooperation at the EU level has been proved to be beneficial for reducing risk of hazards. The implementation of the EU legislation encourages MS to tackle hazard issues in an integrated and trans-boundary approach. Common approaches among MS and sharing best practices and knowledge increase efficiency and effectiveness in risk management.* (EEA, 2010) The EU is the best level to introduce the multi-hazard approach. Regulations need to be scaled down and adjusted to local levels. *The different levels of authority involved (EU, national, local, etc.) need to cooperate and complement each other’s activities to ensure sustainable development.* (El-Masri and Tipple, 2002) Most reports encourage a directive, framework or other overall approach on multi-hazard assessment and management of hazards to strengthen the existing EU policy framework. An outline of a draft EU framework is presented in the report “Assessing the potential for a comprehensive community strategy for the prevention of natural and manmade disasters”.

## 6 Defining key criteria

This research aims to address the weaknesses and challenges in natural hazard risk assessment and management in the EU, focusing on mitigation and adaptation. Previous chapters collect information on these topics, both in scientific backgrounds as practices in the EU. This provides a basic understanding in current strengths and challenges and reveals crucial key points. To understand the policy implementation process, the policy framework of the EU must be reviewed. To make a critical analysis a set of key criteria is prepared in this work. It is in the writer’s opinion that these are the most relevant criteria that should be addressed in EU policies. The list of criteria is then used a tool for assessing the current EU policy framework in chapter 7.

The 12 key criteria can be classified in 3 main areas: governance, participation and hazard approach. ‘Governance’ and ‘participation’ cover important concepts within the implementation of policies and actions. They are crucial to make the system work and to avoid problematic issues on the way. The third area ‘hazard approach’ addresses the content of the policies and actions. This can be divided in several steps. Figure 5 explains the subdivisions, following the criteria are summarized and explained. For all criteria there are references from literature that imply or suggest these elements or approaches.

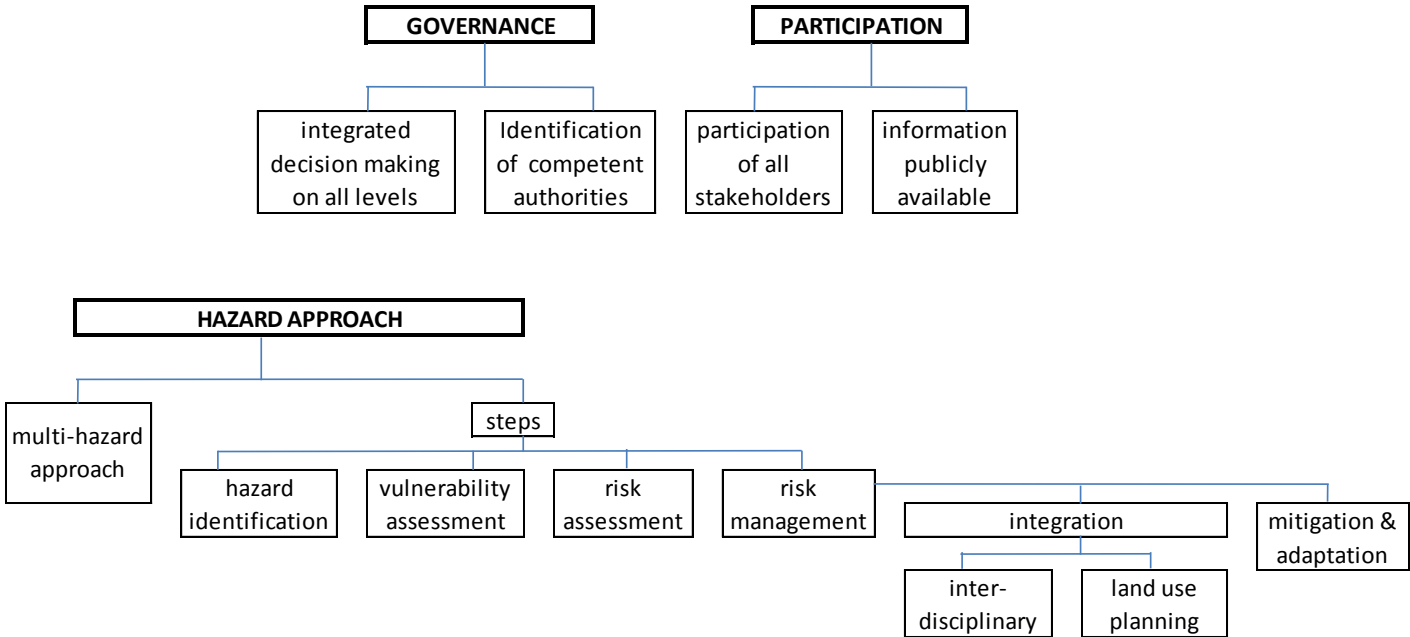


Figure 5: Key criteria scheme



## **Governance**

### 1. Integrated decision making on all levels:

The main authorities in hazard assessment and management are settled on European, national, regional and local levels. Each level carries a responsibility towards society and concentrates on their tasks. Legislation on the highest level (EU) are scaled down and adjusted to the local circumstances. Good cooperation and integration between all levels is essential to ensure effective results. Paragraph 4.7 addresses some scientific papers related to the implementation of policies and its challenges. The relationship between the different levels in EU case related to spatial planning is explained in paragraph 5.4.

### 2. Identification of competent authorities:

One of the most effective approaches for policy implementation is to appoint a specific authority concerned with those issues. This means that responsibilities and data should not be scattered over different institutions, departments, authorities, etc. but an integrated approach on natural hazard mitigation is made possible. Such authority can monitor and control the process, provide advice and inform and include stakeholders. For example national platforms are defined as multi-stakeholder national mechanisms for disaster risk reduction at different levels: from communities to the national institutions. They create a combined organised authority level. (EEA, 2010) This approach is also suggested in the Hyogo Global Framework. (ISDR 2005)

## **Participation**

### 3. Participation of all stakeholders

All stakeholders must be involved so that they can contribute to the process and create additional opportunities. Their input is according to their own capacities and skills. Their involvement also increases implementation efficiency on local level. Many researches mention the importance of the participation of all stakeholders, including the general public. The reports from the EEA (EEA, 2010) and EC DG Environment (EC DG Environment, 2008a) and a paper from Armstrong M.J. (Armstrong, 2010) address the need for a better implementation of the private sector and the public. An interesting paper addressing public participation is “Disaster management and

community planning, and public participation: how to achieve sustainable hazard mitigation” (Pearce L, 2003)

#### 4. Information available to the public

All information should be made available to the public. By informing the public of all steps in the hazard management process, awareness can be improved. Moreover, with openness and transparency there will be less resistance towards new actions and regulations. Such approach should be a part of the mitigation strategies. (Berke and Smith, 2009) Burby promotes to inform the public in order to motivate the community to address natural hazards (Burby, 1998)

### **Hazard approach**

#### 5. Multi-hazard approach

Only a multi-hazard approach takes into account all possible risks related to natural hazards. As long as the focus remains on single-hazard approaches, serious threats are neglected by ignoring consecutive and simultaneous impacts of multiple hazards. Moreover, prevention measures might not be complementary. A mitigating measure for one hazard could bring more vulnerability for another. Therefore, the only effective approach is by implementing multi-hazard risk assessment and management. The need for a multi-hazard approach is addressed in several scientific researches. (see §4.5.1) There are many projects and studies in particular focused on the EU (see §5.2 and §5.3). The study “Principles of multi-risk assessment” addresses the importance of a multi-risk assessment, clarifies several key ideas and presents a new quantitative procedure. (Marzocchi *et al.*, 2009) The ARMONIA project (Assessing and mapping multiple risks for spatial planning) is another influential study which developed a new approach to produce integrated multi-risk maps. (ARMONIA, 2007) Further a guideline is presented from the European Commission (EC (2010) SEC 1626 final) addressing risk assessment and mapping based on a multi-hazard approach.

It is both in scientific circles as in policy levels acknowledged that a multi-hazard approach is necessary. However a particular study has shown how much this remains a challenge in the EU. (Greiving *et al.*, 2006) Therefore it is crucial to integrate the multi-hazard approach in the policies on EU level.

#### 6. Steps: Hazard identification

Dealing with hazards starts with identifying all hazards and their impacts. Such identification reviews events from the past and applies this to scenarios which create an image of possible future events. Prioritisation of hazards is also important in this step. This first step of a natural hazard risk assessment process is identified in most related literature. Paragraph 4.5 provides explains the elements of a hazard assessment, which is considered equal to hazard identification in most literature. Paragraph 5.2 integrates hazard identification in a multi-hazard risk assessment process. It is widely acknowledged this is the first crucial step in natural hazard assessment.

#### 7. Steps: Vulnerability assessment

It is necessary to find out the weaknesses of society that are vulnerable for the impacts of natural hazards. Since vulnerability causes higher risks, they should be assessed in order to manage them. Vulnerability assessments are therefore a critical tool preliminary to risk management. The concept and importance of vulnerability is explained in §4.2. A multi-risk approach entails a multi-hazard assessment with a multi-vulnerability perspective. (Carpignano *et al.* 2010) Also paragraph 5.2 implements the vulnerability assessment in a multi-risk approach.

#### 8. Steps: Risk assessment

Risk assessment can include a hazard identification and vulnerability assessment. Further it develops a socio-economic impact assessment of hazardous events. Overall potential damages and losses are estimated. Paragraphs 4.5 and 5.2 refer to different literature devoted to (multi-) risk assessment. Risk assessment is implemented in many different levels related to natural hazards, it is acknowledged as a necessary tool to address natural hazards

#### 9. Steps: Risk management

Following the risk assessment, risk management introduces actions in order to prevent, prepare, respond and recover disasters (see the disaster cycle §4.6.1). Risk management can include mitigation and adaptation measures. Multi-hazard management is addressed in paragraph 5.3. Generally management is always present in natural hazard approaches. There are however great differences in how countries or authorities apply the management.

#### 10. Integration: interdisciplinary

Hazard mitigation measures must be integrated in all related sectors (sustainable development, energy, spatial planning ...). It ameliorates the implementation and cooperation between sectors. Mutual benefits can be obtained and addressed. Regulations, laws and policies can be adjusted and complemented to each other. It leads to less issues and difficulties in implementation and new opportunities can be explored. A report from the EC indicates a need for more comprehensive approaches that require a cross-cutting thinking and integration with different sectors. (EC DG Environment, 2008a) It is addressed as an important factor in a multi-hazard approach (EC DG Environment, 2008b).

#### 11. Integration: land use planning

Land use planning (or spatial planning) is a powerful tool to mitigate for natural hazards by decreasing vulnerabilities and therefore risks. Applying this tool prevents further unsustainable growth of settlements and communities. Paragraph 4.3 addresses the importance of this integration by referring to different literature resources. Paragraph 5.4 acknowledges the need for it in the EU and the challenges by implementing such a strategy.

#### 12. Mitigation and adaptation

Pre-disaster approaches are proven to be more efficient than post-disaster approaches in terms of preventing loss of human lives and reducing social, economic and environmental impacts. Therefore a shift from response to prevention is necessary. Mitigation and adaptation are the key tools for achieving sustainable and resilient communities. The concepts are explained in a scientific framework in paragraph 4.4. Prevention actions (see §5.3.1) are referring to both concepts as well.

## 7 Critical assessment of the criteria on current policy framework in the EU

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The purpose of this chapter is to define the policy framework of the EU related to natural hazards and assess it by the key criteria from chapter 6. With this tool it is aimed to find strengths and weaknesses in the policy framework and acknowledge current challenges. This results in a critical review. First it is explained how the policy framework is defined. The appointed framework consists of a selection of most relevant documents in natural hazard assessment and management. They include Directives, Communications, a White Paper and Eurocodes. In the conclusions an overview is given on the key criteria with all policies.

### 7.1 Defining the policy framework

The policies in this chapter are collected by using references from literature. They can be downloaded from the EU online database where all EU law is available<sup>1</sup>. Making a search in the database is complex unless the user exactly knows which policy he or she is looking for. Another option of looking into the EU policies in a more user-friendly manner can be found on the official website of the European Commission<sup>2</sup>. Here a number of key areas in the EU law are presented. However amongst those there is no specific key area appointed to hazards. Moreover the policies that can be found are scattered in different areas. Unlike climate change; this is addressed as a separate key area and integrated in most other key areas.

Following documents are considered most influential, relevant and up-to-date policies related to natural hazard assessment and management in the EU and will be assessed one by one in this chapter:

#### Directives

- Water Framework Directive (2000/60/EC)
- Directive on the assessment and management of flood risks (2007/60/EC)
- Directive on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection (2008/114/EC)

#### Communications

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<sup>1</sup> <http://eur-lex.europa.eu/>

<sup>2</sup> <http://ec.europa.eu>

- Communication addressing the challenge of water scarcity and droughts in the European Union (COM(2007) 414 final)
- Communication on reinforcing the union's disaster response capacity (COM(2008) 130 final)
- A Community approach on the prevention of natural and man-made disasters (COM(2009)82 final)
- The EU internal security strategy in action: 5 steps towards a more secure Europe (COM(2010) 673 final)
- Towards a stronger European disaster response: the role of civil protection and humanitarian assistance (COM(2010) 600 final)

### **Council conclusions**

- Council EU: Conclusions on a community framework on disaster prevention within the EU (Council of EU, 2009)

### **White paper**

- Adapting to climate change: Towards a European framework for action (COM(2009) 147 final)

### **Eurocodes**

## **7.2 Directives**

### **7.2.1 *Water Framework Directive (2000/60/EC)***

Due to increasing pressure from the continuous growth in demand for sufficient quantities of good quality water for all purposes, a framework was needed to combine the basic principles of sustainable water policy in the EU. As a result the Water Framework Directive (WFD) was established as an integrated Community policy on water. The WFD aims at maintaining and improving the aquatic environment in the Community by inter alia promoting sustainable water use based on a long-term protection of available resources. This objective is related to natural hazards, in particular in contribution to mitigating the effects of floods and droughts. The WFD itself does not imply hazard risk assessment; nevertheless it is important to integrate it with the relevant natural hazard policies. The Flood Directive (§7.2.2) aims to attain such integration. Consequently flood protection is connected with environmental

objectives. Moreover the MS will conduct requirements from each directive, without compromising the other. More on this will be explained in §7.2.2.

The WFD strives for integration of protection and sustainable management of water into other Community policy areas such as energy, transport, agriculture, fisheries, regional development policy and tourism. Common principles and an overall framework for action are desired. Similar could be presented for other policies related to natural hazards.

Close cooperation and coherent actions between the MS with all other levels (EU, regional or local) is considered as a key element for success. Therefore the directive obligates to identify appropriate competent authorities. This must be performed for each river basin district. It also includes informing, consulting and involving the public.

Some of the key criteria from chapter 6 are strived for in this directive: integrated decision making on all levels, identifying competent authorities, participation of all stakeholders, informing the public, creating interdisciplinary integration and focusing on mitigation.

What still seems to be missing is a multi-hazard approach and several of its steps namely hazard identification, vulnerability assessment and risk assessment. There is also no integration with spatial planning.

Vulnerability assessment and land use planning are necessary for tackling the underlying factors of high risks. The WFD recognises land use as an important human impact on water resources. Therefore a summary on land use in the river basins is required from the MS. However there is no interaction between mitigation and land use planning.

Except for a recommendation on taking into account of the vulnerability of certain aquatic ecosystems, vulnerability is not further addressed. With a multi-hazard approach this directive could be integrated with all policies regarding natural hazards and mitigation measures can be complemented. A good start is the full integration of the Flood Directive with the WFD.

### ***7.2.2 Directive on the assessment and management of flood risks (2007/60/EC)***

The European Flood Directive (FD) has been established to reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity. It requires MS to assess if all water courses and coast lines are at risk from flooding, to map the flood extent and assets and humans at risk in these areas and to take adequate and coordinated measures to reduce this flood risk.<sup>3</sup> This is presented in a step-wise action plan that results in flood hazard maps, flood risk maps and flood risk management plans. Prevention, protection

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<sup>3</sup> [http://ec.europa.eu/environment/water/flood\\_risk/](http://ec.europa.eu/environment/water/flood_risk/)

and preparedness are in the main focus of these plans. The FD is generally accepted and often appointed as a profound, solid policy with enough flexibility. There are suggestions for a wider applicability towards other natural hazards.

A preliminary flood risk assessment, including hazard identification, is already executed by the MS by 2011. They include at least: maps of the river basin district, a description of the floods occurred in the past, and depending on specific needs of MS, an assessment of the potential adverse consequences of future floods.

Continuing the flood risk assessment, the MS will prepare flood hazard and flood risk maps, which must be associated with different scenarios. Each scenario has to include the flood extent, water depths or water level and where appropriate, the flow velocity or the relevant water flow. Flood risk maps will then express: the indicative number of inhabitants potentially affected, the type of economic activity affected, installations concerning integrated pollution prevention and control which might cause accidental pollution in case of flooding and potentially affected protected areas and any other information which the MS considers useful. By determining the impacts, taking into account issues such as the effectiveness of existing manmade flood defence infrastructures, the position of populated areas, areas of economic activity and long-term developments including impacts of climate change on the occurrence of floods, and using the flood risk maps, a link can be made to vulnerability assessments. However it is up to the MS how to determine impacts and consequences of future floods, moreover the directive does not obligate or imply recommendations towards vulnerability assessments. It would be recommendable to strengthen this issue.

The following step covers the flood risk management plans. The components of the management plans are set out in the annex of the FD. The plans have to take relevant aspects into account such as costs and benefits, flood extent and flood conveyance routes, areas which have the potential to retain flood water, such as natural floodplains, the environmental objectives of the WFD, soil and water management, spatial planning, land use, nature conservation, navigation and port infrastructure. The objectives regarding the management of flood risks are to be determined by the MS themselves and should be based on local and regional circumstances. Tailored solutions on local level are necessary. It should also be mentioned that the environmental objectives included in the WFD still need to be achieved. As mentioned in §7.2.1, the FD and WFD have to be carried out in coordination. It is aimed to achieve an integrated river basin management which contains both river basin management plans and flood risk management plans. It makes the environmental objectives, laid out in the



WFD, indirectly a part of the flood management. This means that the proposed flood hazard and flood risk maps must be carried out according to the requirements of the WFD. Referring to the key criteria of interdisciplinary integration, the FD does imply such actions; however efforts should be made to improve this. More sectors should be involved and all related sectors should relate their policies with the outcomes of this directive.

Both the FD and WFD approach an active involvement of all interested parties with maps and plans made available to the public. Also long term planning, and focusing on prevention by mitigation and adaptation are objectives co-acting with the key criteria.

The FD allows but does not demand to use the same authorities as chosen for the WFD. In any case competent authorities need to be appointed and communicated to the European Commission. The directive recommends MS to consider the potential impacts that policies referring to water and land uses might have on flood risks and the management of flood risk. With a view on giving rivers more space, it is also recommended to consider the maintenance or restoration of floodplains. Besides the recommendations, the FD does not integrate land use planning and leaves it up to the MS. Several researches have indicated this issue as critical; it is acknowledged that such integration would be beneficial to achieve the objectives of the WFD and FD however most MS fail to do so. Therefore it should be included in the EU policies.

Another criticism concerns the implementation on local level. Full integration between the different authority levels is not accomplished. Decision makers are not always willing to implement the measures that the national authority had in mind. The flexibility of putting MS responsible for their objectives can result in such mismanagement. Two case studies related to this issue are presented in Germany (M.D. Heinz et.al, 2012). The first one focuses on the level of acceptance of the FD among decision-makers and the second one presents recommendations for a successful implementation of flood risk management plans. The research highlights the high level of acceptance towards the FD internationally. However, the first case study shows that decision-makers have different point of views regarding the willingness to accept far-reaching modifications in flood policy. As being in the middle of the process and the directive having strict deadlines the researchers warn that there is a chance that not all of the features of the risk approach will be implemented in a satisfactory manner in the first implementation cycle. The constant revision is then seen as an advantage. The researchers agree that the FD's limitation to framework/process requirements and its abstract objective are a drawback and advantage at the same time. For the second case study it is

concluded that the integration with all stakeholders and all levels in addition with a good communication are critical points.

It would be ideal, integrating this FD into a multi-hazard approach, so that actions for all hazards can complement each other. Within this approach it would be useful integrating the concept of ecosystem services and fulfilling other community goals as well.

### ***7.2.3 Directive on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection (2008/114/EC)***

In 2006 a European Programme for Critical Infrastructure Protection (EPCIP) was established. EPCIP applies an all-hazard approach, although terrorism is given priority. As part of this programme a directive was adopted in 2008: “Directive on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection.” This directive constitutes a first step in a step-by-step approach to identify and designate European Critical Infrastructures (ECI) and assesses the need to improve their protection by complementing existing sectorial measures. ECI’s are defined as all assets, systems or parts located in the MS which are essential for the maintenance of vital societal functions, health, safety, security, economic or social well-being of people of which the disruption or destruction would have a significant impact on at least two MS. Protection in this context is defined as: all activities aimed at ensuring the functionality, continuity and of integrity of ECI’s in order to determine, mitigate and neutralise a threat, risk or vulnerability. Prevention with emphasis on mitigation is an essential part of this directive. This means hazard management is addressed in this directive; however it remains the MS’ responsibility how to define and address the management options.

It implies an all-hazard approach, which means that the critical infrastructures need to be protected for all hazards. It does not give a clear perspective on which hazards should be taken into account. Furthermore the main focus is on terrorism, which makes it questionable how natural hazards should be considered. It is also not mentioned if this includes simultaneous or consecutive occurrence of multiple natural hazards. The directive could strengthen the all-hazard approach to a well-defined multi-hazard approach.

The directive is also isolated in the process of other hazard assessment and management. The identification and designation of the ECI’s are conducted through criteria related to the

function of the infrastructure and the possible impacts on the community when disasters would occur. In other words the vulnerability of the affected communities related to the infrastructures is assessed. Therefore it can be considered as a regulatory tool for vulnerability assessment. It is not specifically addressed how to determine the vulnerabilities. Integration of this directive with other policies (in a multi-hazard perspective) and with other sectors is a concern. The directive does not include any recommendations towards hazard identification or risk assessment. Since the MS need to implement mitigation actions, they will probably need to apply these assessments. It would be recommendable to include this in the directive.

The first step of the process is the identification of the ECI's which will be continued in an on-going process. The cross-cutting criteria for identification are: casualties, economic effects and public effects. The thresholds of the criteria shall be based on the severity of the impact of the disruption or destruction of the particular infrastructure. The directive mentions it will develop together with the MS guidelines for the application of the cross-cutting and sectorial criteria and approximate thresholds. The next step implies the designation of the ECI's. Bilateral and/or multilateral discussions are inevitable here since ECI's could affect other MS than the one it is located in. The MS are also required to set up operator security plans; these identify the critical infrastructure assets of the ECI for which security solutions exist or are being implemented for their protection. A very short description of such plans is set out in the annex of the directive. A security Liaison Officer has to be appointed in each Member State as the point of contact for security related issues between the owner/operator of the ECI and the relevant Member State authority.

The directive is concentrated on the energy and transport sector but recommendations are including more sectors when the directive will be reviewed. Original identified sectors were: Energy, Nuclear industry, Information, Communication Technologies, ICT, Water, Food, Health, Financial, Transport, Chemical industry, Space, Research facilities. A proposal for amending the Directive is in process; especially an inclusion of the ICT sector seems most likely.

It is in hands of the MS their selves to appoint relevant national critical infrastructure protection authorities. How the integration with authorities or other sectors (e.g. environmental protection) runs, is up to the MS. There is no inclusion of local level in this directive; the whole process is arranged between national level authorities and the appointed Security Liaison Officers with the EU as monitoring actor.

This is the first policy that obligates MS to conduct vulnerability assessments with the EU monitoring the process. The directive aims for a long term planning but can be considered as isolated towards other natural hazard mitigation. It does not integrate with land use planning nor does it include cooperation with the public. The latter is partly due to security reasons, considering the vulnerable position of the sectors. It is recommendable to extend this directive to other sectors and strive for vulnerability assessments of the whole community. Then it will be necessary to include all stakeholders and improve integration.

More detailed guidelines are necessary, it is already mentioned in the directive that the EU will provide access to best practices and methodologies as well as support training and the exchange of information on new technical developments related to critical infrastructure protection.

This directive is also reviewed by Christer P. (2009). He criticizes the rather unstable definition of critical infrastructure (CI). It is observed that CI has a different meaning in different times and areas. Some countries address these issues as a part of the general national emergency management system while others base the CI concept on the traditional total civil defence system. There are some unanswered questions related to the directive: how many countries should be involved, how to define the severity of EU level disturbances, what about infrastructure outside the EU, etc. It is recommended in this paper to strengthen the definition of the EU level of responsibility.

Further he argues that resilience is the concept that should be focused on, rather than just protection. As in this brief review, he questions the all-hazard approach with terrorism as first priority.

### **7.3 Communications**

Communications from the European Commission have the aim of informing on their actions in the near future. It also gives suggestions and proposals for the MS. It is therefore not a binding legal framework such as the directives. However it can serve as a guideline for the MS.

### **7.3.1 *Communication addressing the challenge of water scarcity and droughts in the European Union (COM(2007) 414 final)***

This Communication presents an initial set of policy options at European, national and regional levels to address and mitigate the challenge posed by water scarcity and drought within the Union. Challenges to be tackled according to this communication are: full implementation of the Water Framework Directive, ineffective water pricing policies, integration of land-use planning as it is one of the main drivers of water use, decreasing the waste of water by improved water saving across Europe, further integration of water-related concerns into water-related sectorial policies and base policy actions on high-quality knowledge and information of current challenges in water scarcity and droughts. It acknowledges that existing European and national assessment and monitoring programmes are neither integrated nor complete. A set of policy options is then proposed to attack these challenges. At EU level a need is expressed to integrate water management with other sectors such as sustainable agriculture, biofuel development and environmental protection. Other recommendations imply exchanges of information and best practices on drought risk management and identify methodologies for drought thresholds and drought mapping. Several researches and projects have been established since this communication was published.

The communication encourages MS to identify river basins which face quasi-permanent or permanent water stress or scarcity. Hazard identification and vulnerability and risk assessment are not addressed. There are some recommendations concerning drought risk management.

Further the communication aims to address long term planning including the integration with land use planning and other mitigation or adaptation measures.

A specific authority is not acknowledged, but it does aim for integration over all levels. Raising awareness and informing the public is integrated in the approach. Consultations from the stakeholders are a key issue in the communication, however full integration of them is not clearly addressed.

### **7.3.2 *Communication on reinforcing the union's disaster response capacity (COM(2008) 130 final)***

In 2008 this communication was published to make proposals to reinforce the EU's disasters response capacity, building on what had already been achieved. A need is recognised for a stronger EU capability. Although this document mainly focuses on disaster response, which is only one part of the disaster management cycle, it is acknowledged a comprehensive approach

is necessary. This includes risk assessment, forecast, prevention, preparedness and mitigation (pre- and post-disaster), bringing together the different policies, instruments and services available to the EU and MS working as a team. The communication recommends reinforcing existing links between civil protection and environmental policies in order to take full advantage of the preventive measures included in environmental legislation and to ensure an integrated EU approach to disaster prevention and mitigation. Cost effectiveness concerns and resource constraints call for a managed, coordinated and integrated response. Both horizontal as vertical integration is intended to be improved. The aim of this communication is to improve coordination of disaster response activities. Although there is some effort for combining this with preparedness and prevention, there are no measures or tools mentioned which could link these actions to mitigation or adaptation. The proposed action plan includes a better inter-institutional cooperation, reinforced EU humanitarian aid, geared up EU civil protection and strengthening capacity across the EU policies and instruments. There is a strong connection between disaster response and civil protection. There is a commitment laid out by the Commission to improve the effectiveness of its action in cooperation with MS, international, national and local stakeholders. A step is made to include all stakeholders, although there doesn't seem any reference towards public participation. Except for integrated decision making on all authority levels, none of the key criteria is addressed in the first part of this communication. However the annex concerns a different issue and is reviewed separately.

The annex of this communication is more interesting for this research since it is related to all hazard management actions: prevention, preparedness, response and recovery. It is focused on forest fires. The document puts a strong connection with climate change. Climate-resilient forest management measures will be the key to increase the capacity to adapt to climate change. Forests play an important role in ensuring efficient water retention in dry regions, protecting water courses against excessive nutrient inflow, improving flood management, and maintaining and restoring multifunctional landscapes. In other words, forests contain many opportunities towards hazard mitigation.

The annex provides a short overview on future measures and policies on prevention, preparedness, response and recovery. So far policies for prevention of forest fires have only existed on national level. The role of the EU has been limited to providing funds. For future changes it refers to on-going studies and a future guideline on the prevention of forest fires. The EU supports activities aimed at enhancing the MS' civil protection preparedness, notably through financial support and providing courses. A network is proposed linking existing

centres of excellence of the MS to enhance the services and capacity of teams and modules from different MS to work together. Also for response and recovery the main task for the EU lays on financial resources. It seems it is up to the MS to fill in each part of the disaster management cycle. Financial resources might be divided by the EU so that e.g. a certain amount of money has to be spent on prevention. A series of causes of forest fires are summarized, but there are no measures proposed how to mitigate them. For example the mismanagement of practices of agricultural land and forests is clearly related to spatial planning.

There is no reference to a multi-hazard approach, it is only focused on forest fires. It lacks suggestions of integration with other sectors and spatial planning even though the problems are identified. The annex remains vague and isolated; therefore not many of the key criteria are addressed. A stronger role for prevention is recommended, the communication refers here to other studies.

### ***7.3.3 A Community approach on the prevention of natural en man-made disasters (COM(2009)82 final)***

This communication was adopted by the EU in contribution of the Hyogo Framework. It expresses the lack of a strategic approach at the EU level for disaster prevention. Prevention in this context is understood as where possible preventing disasters from happening and where they are unavoidable taking steps to minimise theirs impacts. The communication recognises that the growing vulnerability to disasters is partly as a consequence of increasingly intensive land use, industrial development, urban expansion and infrastructure construction. It presents 3 key elements of an EU approach on prevention.

First, conditions have to be created for the development of knowledge based disaster prevention policies at all levels of the government. This is or will be accomplished by an inventory of all information on disasters, spreading best practices among the MS, developing guidelines on hazard and risk mapping and encouraging research activities.

The second key element is to link the actors and policies throughout the disaster management cycle: prevention, preparedness, response and recovery. Important is the involvement of different public and private stakeholders. A European network is intended to be created covering the departments in charge of land use planning, risk and hazard mapping, protection of the environment, and emergency preparedness and response.

The third key element is focused on better performance of existing instruments for disaster prevention which are funding and legislation. A review is proposed on existing legislation such as environmental impact assessment with the effects on disaster risk prevention. The Eurocodes are mentioned for mitigating the impacts of earthquakes.

This communication sets out an overall approach to the prevention of disasters. It can be considered as an important first step towards a better integration. However many of the key criteria are missing in this proposal. A multi-hazard approach is not mentioned. There is also no reference to vulnerability or risk assessments or hazard identification. Prevention measures are quite limited; hazard and risk mapping (mitigation) and early warning systems (preparedness) are regarded as important tools. An interesting comment is that some approaches, currently applied to specific sectors, could be more widely used. For example the Flood Directive includes hazard and risk mapping and risk management procedures while the Seveso Directive includes provisions on land use planning, safety reports and emergency plans, it might be that these techniques could be useful with the prevention of other disasters. Such methods could be applied in a multi-hazard approach, by sharing and complementing existing ideas. Integration with other sectors is somehow acknowledged but should be extended. There is a first approach towards integration of land use planning. Although it doesn't go into details, one of the important aims is to keep track on prevention with mitigation and adaptation as first approach. One of the key issues this communication tries to address is better integration, with the public, other stakeholders and between authorities. Also informing the public is considered important. There is no specific authority identification laid out.

This document provides a closer look in what the Commission is preparing to establish or improve in the next coming years. It gives crucial key points for tackling challenges however some important approaches are still missing.

#### **7.3.4 *The EU internal security strategy in action: 5 steps towards a more secure Europe (COM(2010) 673 final)***

Only a small part of this communication is dedicated to natural hazards. One of the objectives is to increase Europe's resilience to crises and disasters. Different actions are proposed in order to achieve this objective. First the solidarity clause must be fully used into practice, which gives a legal obligation on the EU and its MS to assist each other when a Member State is suffering from a disaster. Secondly, an all hazard approach is recommended. This is



referring to the risk assessment and mapping guideline which is based on a multi-hazard and multi-risk approach. The third action implies the link up of different situation awareness centres, by developing an integrated approach based on a common and shared appreciation in crisis situation. Different networks have to be set up to share, analyse and assess the available information. An effective coordination between the EU institutions, bodies and agencies requires a coherent general framework to protect classified information. The fourth action is focused on the development of a European emergency response capacity. An internal working group is to be established to ensure a successful implementation.

Some main directions the EU is willing to take in coming years are briefly explained. This document is considered important in dealing with hazards, however it does not contribute to the aim of this research and is therefore not assessed by the key criteria.

#### ***7.3.5 Towards a stronger European disaster response: the role of civil protection and humanitarian assistance (COM(2010) 600 final)***

This communication is again only focused on disaster response although an approach is aimed to balance response with disaster prevention and preparedness. It is also recommended to link this work with the EU efforts related to the adaptation to climate change. The document goes into detail which measures should be taken to improve the disaster response. Similar to the communication in 7.3.4 this document is not assessed by the key criteria. However a conclusion can be made by revealing such documents: it indicates that disaster response is still much more on the agenda of the EU than hazard mitigation or adaptation.

### **7.4 Council conclusion**

The European Council defines the general political direction and priorities of the EU. It does not exercise legislative functions but merely expresses the necessary impetus for the development of the EU.

#### ***7.4.1 Council EU: Conclusions on a community framework on disaster prevention within the EU (Council of EU, 2009)***

As a follow-up of the communication discussed in §7.3.3 the Council of the European Union adopted in November 2009 ‘Conclusions on a community framework in disaster prevention within the EU’. It lists the initial actions that should be taken by the European Commission in the following years. It also provides a summary of relevant policy documents that should be

taken into account regarding the prevention of hazards. The council conclusion recognizes the importance of effective disaster prevention. Several crucial actions are mentioned here. The emphasis lays on climate change when it comes to adaptation. A cross-sectorial approach is stressed out in order to enhance synergies and emphasising the need for increased actions across all levels and by all relevant actors.

Important is that it underlines the usefulness of a multi-hazard approach in an EU disaster prevention framework which should be complemented, where appropriate, with hazard-specific measures. It states that EU prevention should complement and further support national initiatives and develop synergies with existing national and international work. Similar with the communication, integration with all actors and policies is an important key issue. The conclusion recommends raising public awareness and informing and educating the public on prevention. It is also supported to create a national disaster risk reduction platform, as appointed in the Hyogo Framework for Action. It emphasises that hazard and risk identification and analysis, impact analysis, risk assessments and matrices, scenario development, risk management measures, and regular reviews are major components of the EU disaster prevention, and recommends elaborating these areas. Vulnerability assessment is specifically addressed, although many policies and documents still lack this approach. Integration with land use planning is also not addressed.

It is recommended to work further on the communication discussed in §7.3.3 for the on-going and future work on adaptation. This document indicates more efforts are necessary and EU efforts should be integrated, notably regarding adaptation to climate change.

## **7.5 White paper**

White papers are documents containing proposals for the Community to take action in a specific area. When a White Paper has been favourably received by the Council of Ministers, it may become the action programme for the Union in the area concerned. It is circulated to the community institutions however it is not a legislative text.<sup>4</sup>

### **7.5.1 *Adapting to climate change: Towards a European framework for action (COM(2009) 147 final)***

As explained in chapter 4, climate change is closely related with natural hazards. An expected increase in severity of weather-related natural disaster has made people recognise the need for

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<sup>4</sup> [http://ec.europa.eu/youth/archive/whitepaper/backinfo/backinfo1\\_en.html](http://ec.europa.eu/youth/archive/whitepaper/backinfo/backinfo1_en.html)

response. Two types actions are explained in this paper: mitigation actions (e.g. reduce the greenhouse gas emissions) and adaptation actions. The latter are scattered and require a more strategic approach to ensure coherency across different sectors and levels of governance. This would also ensure that effective adaptation measures are taken in time. This White Paper sets out a framework to reduce the EU's vulnerability to the impact of climate change by complementing existing actions by the MS and support wider international efforts. This paper is developed in a cross-cutting manner. Impacts are considered in a number of sectors and integration is encouraged in all those sectors.

It is acknowledged that ecosystems play a direct role in climate regulation, offering protection against many natural hazards. Some land use practices and planning decisions, as well as unsustainable use of the sea have put our ecosystems at danger. This leads to a higher vulnerability and lower capability of adapting. It is therefore important to understand how ecosystem conservation and rehabilitation is a necessary element of hazard mitigation and adaptation. Working with nature's capacity to absorb or control impact in urban and rural areas should be more integrated in all natural hazard policies.

For not disturbing the dynamic of nature one has to be careful about 'mal-adaptation' practices, which could do more harm than good and increase vulnerability. Therefore adaptation measures should not be left only to individuals or businesses. Decent information and a level of good knowledge are necessary. The awareness should also be improved on the fact that costs of adaptation or mitigation measures will be much lower than costs of inaction over longer term.

To improve the EU's resilience on impacts of climate change, an adaptation framework is proposed which has 3 phases. The first phase contains several actions. In order to have a success for this first phase, the EU, national, regional and local authorities must cooperate closely. One of the actions includes the development of a knowledge base on climate change impacts, vulnerabilities and best practices on adaptation. It is acknowledged that vulnerability must be assessed against a wide range of climate scenarios and on different geographical scales so that adaptation measures can be defined as precisely as possible.

It is further aimed to mainstream adaptation to climate change into EU policies. Moreover it is advised to review in each policy area on how to re-focus or amend to facilitate adaptation. This would also be a part of phase 1 in the framework. Further, priority should be given to adaptation measures that would generate net social and/or economic benefits irrespective of uncertainty in future forecasts (no-regret measures).

This framework aims for a full integration, covering all relevant sectors (agriculture, forestry, etc.), all levels of authorities (EU, national, regional and local) and with all related EU policies (Flood Directive, environmental protection policies, spatial planning, etc.). Efforts are being done to integrate the concept of adaptation for climate change in all related legislation.

Within the framework of this paper, the Commission intends to set up an Impact and Adaptation Steering Group (IASG) which will be composed of representatives from the EU MS involved in the formulation of national and regional adaptation programmes and will consult with representatives from civil societies and the scientific community. This group will play a role in developing this framework and prepare national adaptation strategies by the MS. Many concepts of this framework can be useful for hazard mitigation and adaptation regarding a multi-hazard approach. A comprehensive EU adaptation strategy is expected to be developed by 2013. Although it is not explained in detail, this white paper encourages vulnerability assessments, further there is no link with risk assessment. Most key criteria are found in this document, except for applying a multi-hazard approach. Climate change and not hazards are the subject however many key criteria are more addressed in this climate change guideline than in natural hazard policies. It is clear those policies need to be extended and strengthened. Several concepts can be copied from climate change policies, as mentioned before mitigation for climate change can serve for hazard mitigation as well.

## **7.6 Eurocodes**

The EN Eurocodes include 10 standards (EN 1990 - 1999) covering various subjects related to new construction. They provide a common approach for the design of buildings and other civil engineering works and construction products. Different parts are related to natural hazards; these can be considered as a tool for mitigating the impacts by integrating them in national planning regulations. The summary below gives these links between the Eurocodes and natural hazards.

### **Forest fires**

Eurocode 1 (actions on structures) defines protective design measures against fire for buildings made of various materials (steel, concrete, wood, masonry)

### **Ground movements**

Eurocode 7 defines calculation and design rules for stability of buildings according to geotechnical conditions of construction site (XP ENV 1997, PR EN 1997-2, ENV 1997-3)

## **Earthquakes**

Eurocode 8: EN 1998-1 (general rules, seismic actions), EN 1998-3 (assessment and strengthening of buildings), ENV 1998-4 (reservoir, pipes), EN 1998-5 (foundations, structures), EN 1998-6 (masts, towers...)

## **Storms, Hurricanes**

Wind resistant design of buildings is covered by Eurocode 1 - EN 1991-1-4

## **Cold waves**

Eurocodes cover protection against cold and snow

## **Heat waves and drought**

Eurocode EN 1991-1-5 includes design to resist heat waves. Partly covered by Eurocode EN 1997-1-1 (Geotechnics) (EC (2010) SEC 1626 final)

The Eurocodes could be extended by making integration with vulnerability assessments. The Eurocodes are only focusing on new construction, a similar approach should be in place to restore, improve or upgrade existing vulnerable construction. Existing critical infrastructures and people's housing need to be protected, in particular adapted, to any possible disaster. Especially in Europe where many old and historical building remain present in the settlement patterns this issue should receive more attention. All hazards are taken into account however they are not coordinated with each other. The vulnerabilities of all hazards need to be integrated in a multi-hazard approach. Referring to the key criteria these policies only address mitigation and adaptation measures, considered in the risk management step.

## **7.7 Other policies**

The policy framework defined in this research is not a representation of all available policies in the EU related to natural hazards. The EU contains much different kind of laws and regulations therefore it is aimed to review the most influential ones. Directives are on the highest implementation level. Nevertheless, certain communications, council conclusions, ... give important perspectives on guidelines, future policies, national requirements, etc. The most relevant ones are reviewed in this research.

Further this work is concentrated on policies including natural hazard mitigation, adaptation or any other preventive action management. Policies including all disaster management steps are considered as well. However those who are only focused on response or recovery are not relevant for this research. A few are mentioned in this chapter (see §7.3) to recognize the fact

that there are more policies available on these management concepts rather than on mitigation and adaptation.

Further, it is not in the scope of this research to review all single-hazard policies. Although some are integrated in this chapter, since they can contribute to a multi-hazard framework. Especially the Flood Directive is considered crucial in such process. Some others referring to drought management and forest fires are included as well. For several hazards (e.g. landslides, earthquakes) there are none or very few regulations on EU level. It is observed that hazards which do not occur very frequent are mostly not considered as high priority. It is recommended not to neglect also the risks of those hazards.

## **7.8 Planned policies and research in the EU in the near future**

The 7<sup>th</sup> Framework programme (FP7) is a key pillar for the European Research Area. It bundles all research-related EU initiatives.<sup>5</sup> There are 27 on-going or finished projects in this network related to natural hazards. One in particular is of importance to this research: “new methodologies for multi-hazard and multi-risk assessment”, a project which will be finished by 2013.<sup>6</sup> This project will create a theoretical framework integrating new methods for multi-type assessments, risk comparability, cascading hazards and time-dependent vulnerability.

An initiative is being developed building upon the White Paper "Adapting to climate change: Towards a European framework for action" (COM(2009) 147 final). It foresees the development of a comprehensive EU adaptation strategy by 2013. The new strategy aims to tackle following issues: the knowledge gaps on addressing the adverse effects of climate change in Europe, the EU policies which do not sufficiently take into consideration the need to adapt to negative effects of climate change, the need for awareness raising, the development or capacity to respond to adverse effects, vulnerabilities and adaptation needs, the inclusion of the private sector in increasing their resilience to climate risks. The main policy objectives are: to have a more resilient Europe at national, regional and local level; to facilitate the exchange of good practices and coordination. Further it is also aimed to strengthen the knowledge base on climate change impacts, vulnerability and adaptation and to

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<sup>5</sup> [http://cordis.europa.eu/fp7/home\\_en.html](http://cordis.europa.eu/fp7/home_en.html)

<sup>6</sup> [http://cordis.europa.eu/search/index.cfm?fuseaction=proj.document&PJ\\_RCN=11618493](http://cordis.europa.eu/search/index.cfm?fuseaction=proj.document&PJ_RCN=11618493)

mainstream adaptation into policies, strategies and programmes at EU level (and develop dedicated adaptation action where needed).<sup>7</sup>

Planned policies are mostly addressed in communications, council conclusions or other EU notices. Sometimes it is referred to a guideline which will be made. The main core areas the European Commission is willing to address in the next years are:

- hazard assessment: triggering factors and forecasting
- vulnerability assessments and societal impacts
- risk assessment and management
- multi-risk assessment and mitigation strategies

It is aimed to address these areas in scientific research, inter alia FP7, and by creating new policies or guidelines. (Denis, 2011) The council conclusion discussed in §7.4.1 also recognises the need to improve prevention and to reduce the adverse consequences of hazards and minimise their social, economic and environmental impacts.

Regarding natural hazards, both researches and policies are increasing in amount. The awareness is growing that more policies are needed. However many studies indicate a need for an integrated overall legal framework, which is neither present nor expected in the near future. Therefore more research on this issue is relevant and must serve as driving force to increase and improve the current policy framework.

## **7.9 Overview and conclusions**

A first remark of this chapter is that the policy framework on EU level regarding natural hazards is quite limited. Especially concerning hazard mitigation, there are very few policies introduced. When defining the policy framework in this work, it is also observed that they seem scattered and not integrated. Climate adaptation policies on the other hand have a much stronger implementation and integration in different sectors. On the website of the European Commission (<http://ec.europa.eu>) policies are divided in several key topics. One of those topics is climate change. The policies for natural hazards do not contain a specific topic; on the contrary, they are distributed over several topics. Single hazard mitigation actions are

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[http://ec.europa.eu/governance/impact/planned ia/docs/2013\\_clima\\_002\\_communication adaptation strategy\\_en.pdf](http://ec.europa.eu/governance/impact/planned%20ia/docs/2013_clima_002_communication_adaptation_strategy_en.pdf)

mostly stand-alone actions. Except for the WFD and Eurocodes, all policies are developed recently. This indicates a growth on hazard policies during the last decade.

Another general remark concerns the content of the policies used in this research. It is clear that there are more policies available on disaster response rather than prevention. Moreover these policies have been developed to quite effective and well-coordinated mechanisms for crisis management. Even though it is widely acknowledged a new focus is necessary from post-disaster towards pre-disaster approaches. It means that mitigation and adaptation is underestimated in the EU legislation framework. It is questionable if MS take full control their selves when it comes to a change in mind-set. If the EU mostly improves legacy in disaster response there is not much room left for prevention. However, slowly it seems the EU is encouraging the MS on the integration of prevention measures. Some documents recommend a full integration of all elements of disaster management (mitigation – preparedness – response – recovery). The research available is increasing on this topic and several policies are to be extended or created in the near future (see §7.8).

An overview on the key criteria assessed on all relevant policies is presented in Annex I. Ten policies are considered relevant and important concerning natural hazard management in the EU. Only a few of the reviewed policies in this chapter are not considered in this overview, since they were only addressing hazard response and did not bring any important input for this research.

The overview is presented in three colours, if the criterion is not addressed, encouraged or mentioned in the policy a red colour is given, if it is somehow acknowledged but needs to be strengthened the colour is orange and if the criterion has a powerful meaning in the policy the colour is green. Table 3 gives an overview of all 12 key criteria with the percentage of green colours (which means, the criterion is addressed in this policy). Some conclusions can be made from the overview and table data.

Within the governance key criteria, 6 out of 10 fully address an integrated decision making on all levels, 2 others have acknowledged the importance of it and can improve this. In general, there is an increased awareness of the importance of integration between EU, national, regional and local levels. It has been noticed, without efforts on such integration difficulties occur in the implementation of local actions.



Nearly half of the policies encourage or apply the identification of competent authorities. It is observed that all related directives, which are the most binding legal instruments, address this.

**Table 3: Addressed key criteria in policy framework**

	<b>criteria</b>	<b>% addressed</b>
GOVERNANCE	integrated decision making on all levels	60
	identification of competent authorities	50
PARTICIPATION	participation of all stakeholders	50
	information publicly available	60
HAZARD APPROACH	multi-hazard approach	10
	hazard identification	20
	vulnerability assessment	20
	risk assessment	20
	risk management	90
	interdisciplinary integration	50
	land use planning integration	20
	mitigation and adaptation	90

The key criteria regarding participation: participation of all stakeholders and information publicly available are integrated in about half of the policies. Again, this issue is constantly growing during last years. However still there are several policies not acknowledging participation and information is necessary.

The final criteria group is related to the hazard approach. Only one out of ten policies refers to and recommends a multi-hazard approach. This concept is clearly not integrated in the EU policy framework. The document recommending a multi-hazard approach is a council conclusion and implies addressing this issue more in the near future.

Most policies do not contain information towards hazard identification or risk assessment. It is clear that these steps are mostly regulated by national or local authorities. Only 20 % of the policies encourage, recommend or include vulnerability assessments. This issue is still much underestimated and not wide-spread. The policies addressing such assessment are not integrated with other natural hazard policies therefore the vulnerability assessment stays within a few isolated circles.

Mitigation and adaptation are part of risk or hazard management. Since this research mostly focuses on policies related to such management actions, nearly all contain a risk management

approach or specific actions in this context. It must be mentioned more policies are available regarding disaster response (§7.3.4, §7.3.5 and other) and are neglected in the overview. Since these policies do not contribute to the aim of this research, it is not relevant assessing them by the key criteria.

Regarding integration, there is a considerable difference between policies. 50% encourages an interdisciplinary approach, referring to several relevant sectors which should integrate with the respective policy. In particular spatial planning receives some special attention, however only 20% acknowledges this.

When comparing policies to each other, the communication “adapting to climate change: towards a European framework for action” meets the most key criteria. Not only does climate change receives more attention, due to higher awareness, it is also more advanced than hazard mitigation policies. As mentioned in the review of this policy (§7.5.1) several concepts could be copied towards multi-hazard policies. This is further explained in chapter 8.

It can be concluded efforts are increasing towards prevention, mitigation and adaptation in natural hazard management. Climate change adaptation is considered more advanced and has a stronger policy input on EU level.

## 8 Recommendations and proposals

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This chapter gives an analysis of previous chapters. Each part has given insights in current practices in the EU, revealing strengths and weaknesses. The critical review of chapter 7 using the key criteria provides a clear overview on challenges in the current policy framework of the EU. Combining this information some recommendations and proposals are presented in this chapter.

Only a few policies on single hazard risk assessments are available on EU level: flood risk and drought risk. For most other hazards the MS must adopt national policies. The biggest challenge in the policy framework is to address multi-hazard risk assessment. Most MS do not implement a multi-hazard approach; only a few exceptions are observed. A guideline is established in 2010 on multi-hazard risk assessment and risk mapping. (EC (2010) SEC 1626 final) A future version of this guideline will contain a catalogue of recommended methods and standards for risk assessment.

Other research clarifies the key ideas around the concepts of multi-risk applied in the EU and presents a new quantitative procedure for multi-risk assessment. (Marzocchi *et al.*, 2009)

The ARMONIA research describes a differentiated approach on the assessment of multiple vulnerabilities and produces a framework and decision support tool structure for risk informed planning using multi-scale, multi-risk and multi-vulnerability characteristics. (ARMONIA, 2007) There are more research projects carried out related to multi-hazard approach. The knowledge and methodology is available and explained. Moreover several case-studies have tested new approaches and obtained good results.

Nearly all studies recommend an overall framework. The EU should take action and provide a comprehensive multi-hazard policy, in order to regulate multi-risk assessments in each MS. Clear and specific guidelines and regulatory tools must be integrated with combining existing networks and best practices. Consequently, risks will not be neglected and appropriate mitigation or adaptation measures can be worked out.

These actions should be complementary between different hazards. The management of adaptation and risk planning often falls within some Ministry which can be different for each hazard. Single hazard measures mostly do not consider measures related to other hazards. A multi-hazard perspective would provide a better integration.

It is recommended to create a legal framework, since such a framework will bring more valuable results. This has been observed with the Flood Directive and Water Framework Directive, they have been a major driving force in ecological and flood hazard assessments and management plans. Furthermore, a voluntary approach, such as the use of guidelines, implies some potential weaknesses, as it has no enforcement mechanism and mostly do not apply a monitoring, evaluating and updating system as in legally binding instruments.

Most EU policies do not recognize the need for vulnerability assessments. Moreover risk assessment is mostly considered a national competence. However studies show that common approaches would be more beneficial, e.g. risk assessment and mapping for the FD. More research can be necessary to address multi-vulnerability assessments. The Directive on European Critical Infrastructures provides a first small step towards vulnerability assessment in EU policies. Some proposals to extend this directive are: including more sectors, implying risk assessment and vulnerability assessment methodologies, including all stakeholders and create more integration.

The Eurocodes are policies providing building codes for new construction. Several codes address different natural hazards. An extension of these codes is recommendable, in particular to include also existing vulnerable constructions. Vulnerability assessment and building codes (or other mitigation actions) need to be aligned with each other.

This brings us to the management of hazards, more specific mitigation and adaptation measures. It could be proposed to introduce the use of mitigation plans in the EU policy framework. Such a plan results from a systematic evaluation of the nature and extent of vulnerability to the effects of natural hazards in society. As a minimum, it must contain:

- A hazard identification / hazard assessment in the designated area.
- A description and analysis of local hazard management policies, programs and capabilities for mitigation.
- Hazard mitigation goals and objectives and proposed strategies, programs and actions to tackle long-term vulnerability
- A method of implementing, monitoring, evaluating, and updating the mitigation plan on at least annual basis. (Godschalk *et al.*, 1999)

These key points related to a mitigation plan can largely be found in the FD and WFD. They combine different steps in hazard identification, assessment and management. It is recommended to use the FD as a leading example for a multi-hazard framework.

Not only should an integration amongst hazards and authorities be provided, it should also consider other community goals. An interdisciplinary approach is needed to combine ecological, societal, economic, political, etc. objectives. Enhancement of environmental quality would become a coequal objective with economic development. To achieve such a comprehensive hazard approach, it is necessary to include all stakeholders and in particular involve the public.

The involvement of the public is crucial, but also the awareness of the public. Climate change has achieved much more awareness due to a sudden popularity of the subject. This awareness has been a driving force to create more policies on climate adaptation. There should be more efforts done on increasing awareness on natural hazards. It is also observed that people have created some loss of sense of responsibility and rely on authorities to protect them. Personal responsibility should be more encouraged while risky behaviour should be discouraged and possibly punished. Incentives and grants can create more opportunities on local or individual levels.

A particular interest goes to the integration with spatial planning. Many studies have shown how spatial planning could be a powerful tool in mitigation management for reducing vulnerability. There are large varieties amongst MS and even on regional and local level: an integrated approach is missing. The EU could be a catalyst to support stable political focus on mitigation and spatial planning through applying various means and measures. Furthermore it can coordinate the activities and provide guidance on best approaches. It could provide important functions such as monitoring and spreading knowledge. Providing this on EU level brings more opportunities and common approaches than on national level.

To complete this research work the recommendations and proposals of this chapter are integrated in a proposal for a conceptual multi-hazard policy framework in the EU.

## **9 Proposal for a conceptual EU Multi-Hazard Framework**

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Concluding from the review of policies and studies, it is recommended to create an integrated approach on multi-hazard mitigation. The aim of this chapter is to propose an integrated and comprehensive multi-hazard policy framework at the EU level. This research gives a conceptual proposal as a preliminary step towards a fully developed framework. As mentioned in chapter 8, it is advisable to elect a legally binding framework. Therefore, a directive would be the most appropriate choice. The framework is intended to apply a cross-cutting approach, to complement and integrate the existing tools and instruments and to use existing knowledge and best practices.

This chapter presents the aims and key elements of the conceptual framework together with a proposed basic methodology that can be used for supporting this framework. A special attention is given on the concepts of ecohydrology and ecosystem services. The second part of this chapter presents the different stages of the policy framework proposal connected to existing legislation and guidelines. A draft of a directive is proposed in Annex II.

### **9.1 Conceptual framework and basic methodology**

The scope of this new framework is to decrease vulnerability and therewith the impacts of natural hazards. Coherence and consistency need to be improved among natural hazard policies, therefore this integrated framework shall make risk assessment and risk management more comparable and integrated among the MS. It is important to gather data and knowledge and share best practices.

It is aimed to create integration with other sectors and with other community goals with inter alia the so-called no regret measures. An interdisciplinary approach to natural hazards is crucial. Impacts of disasters affect the economy, social life and the environment. Policies and tools of all kinds of fields must be linked to vulnerability and natural hazards. Climate adaptation has such an approach and can be considered a leading example. Further, the private sector and all stakeholders, including the general public, have to be involved in the process. By encouraging integration on all these levels opportunities and shared interests can be discovered and measures and tools can be adapted to each other.

A significant issue related to natural hazards is the integration with land use planning which is crucial in the mitigation management. By providing information and improving awareness there will be a higher acceptance towards new actions.

In order to achieve full risk estimation a multi-hazard approach is adopted for not neglecting risks other than single-hazard risks.

A methodology approach is presented in a diagram (Figure 6). It represents the conceptual background of a multi-hazard framework with 4 stages in the process and different outputs in each stage. The key criteria defined in chapter 6 are leading issues in this framework. The stages are: risk identification, risk assessment, risk management and monitoring and evaluation. The diagram shows the processes and outputs in each stage.

The risk identification starts from the beginning: the communities and their vulnerability. When natural hazards occur, the impacts can be on many dimensions: social, economic, environmental, etc. In this stage, hazards need to be identified, by inter alia data collection and monitoring. Further it is important to create multi-risk scenarios which include the possible impacts of future hazards.

In the second stage the multi-hazard risk identification and vulnerability assessment develop together a complete multi-hazard risk assessment. Multi-risk mapping is an important tool integrated with risk assessment. A multi-risk estimation gives an overview on the complete risks considered in an area; this involves inter alia the socio-economic impacts.

In the third stage risk management is addressed. This stage contains a framework of actions, in this case focused on mitigation and adaptation. The identification of stakeholders, competent authorities and related sectors is the first step to be taken. They must cooperate and present objectives and mitigation and adaptation actions as part of the mitigation and adaptation plans. Further it is important to integrate issues such as cost-benefit analysis, integration with other community goals and using the ecohydrology and ecosystem service concepts within the new plans. Without considering these integrations, opportunities can be ignored. They are also a means for informing the general public and receiving their support.

The final stage contains a monitoring and evaluating function, in order to improve each time and keep the plans up-to-date.

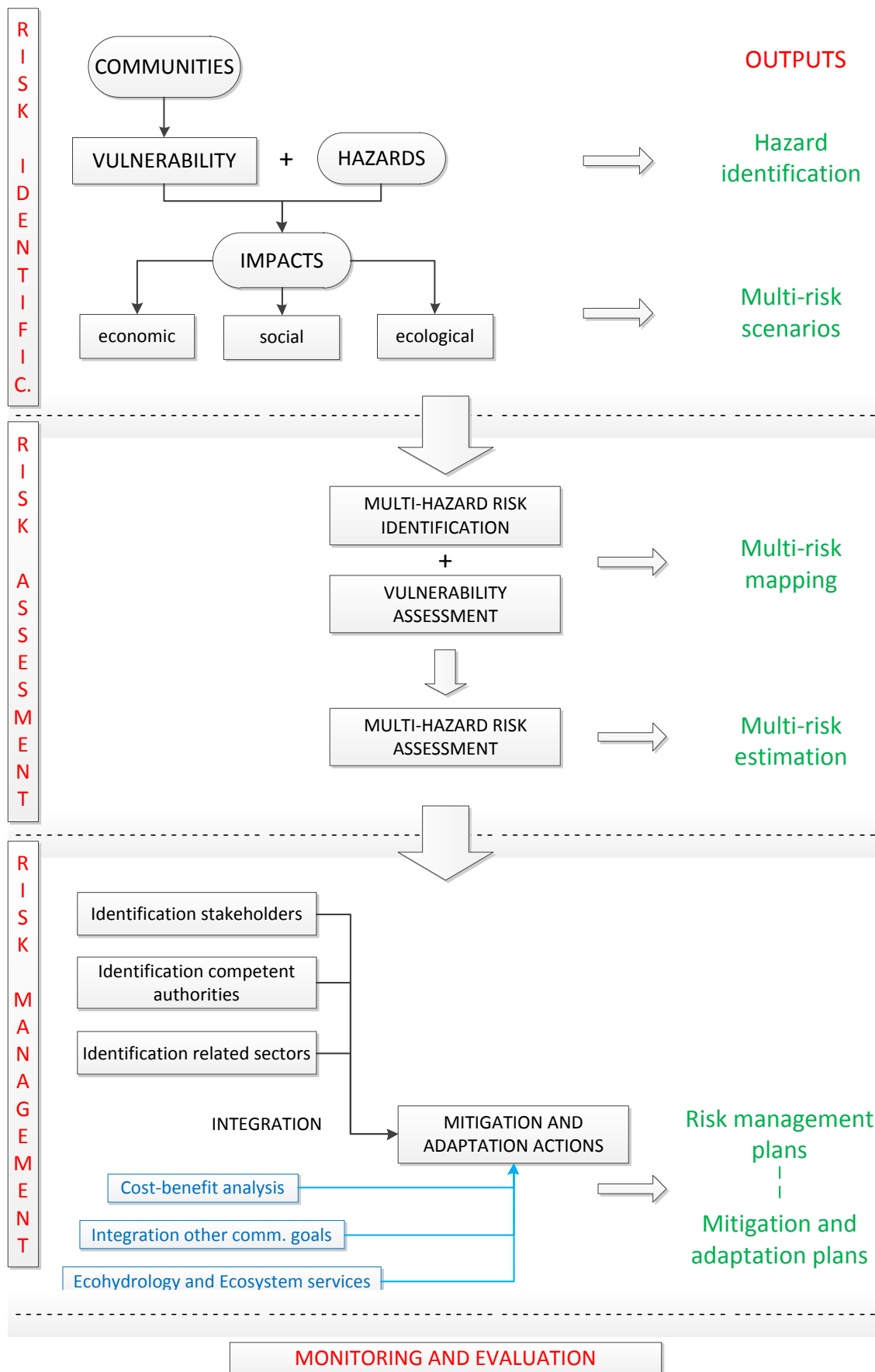


Figure 6: Methodology conceptual framework



In §9.1.1 a closer look is given on the integration of ecohydrology and ecosystem services with natural hazard management. Both concepts are assets to the mitigation and adaptation strategies. The 4 stages of the methodology are further explained in §9.2, which also presents a link with existing guidelines and legislation that can be used for the new framework.

#### 9.1.1 *Ecohydrology and ecosystem services related to natural hazard management*

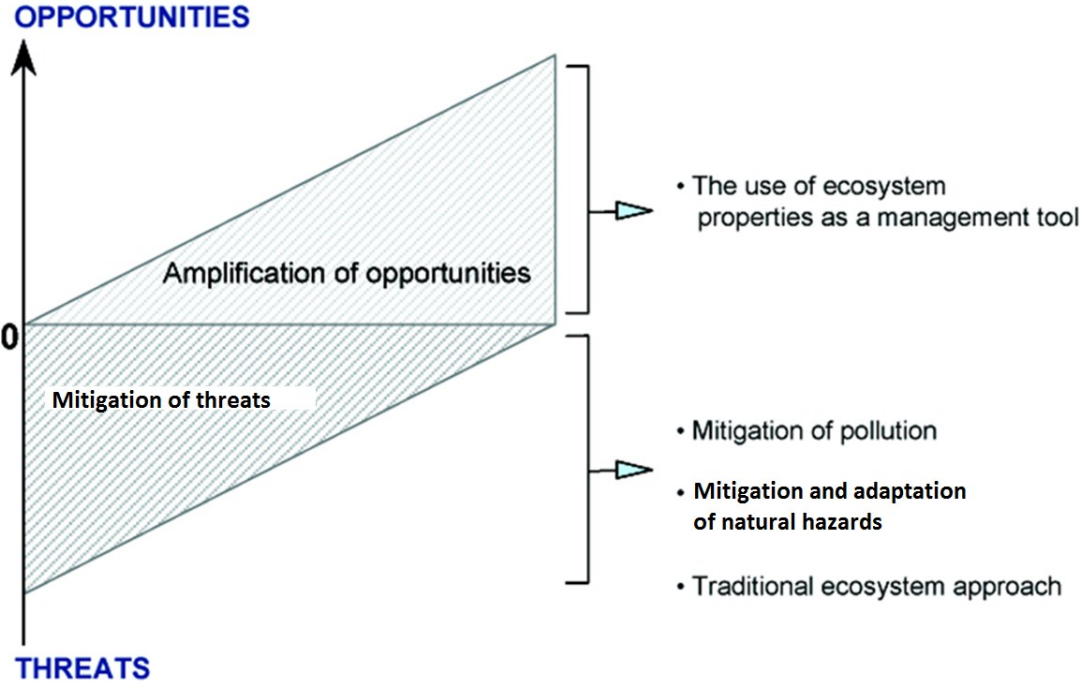
As presented in §4.6.2 it is in the author's opinion that ecohydrology can bring certain assets to a multi-hazard management. In a context of increasing human pressure on the environment the ecohydrology concept seeks new ways to achieve sustainable development.

The ecohydrology approach relates to floods and other meteorological hazards. Flooding is a necessary and natural event for different ecosystems. They contribute to sedimentation and nutrient transport, stimulating high biological productivity in floodplains. However it is also a threat for disasters, mainly due to infrastructures and urbanisation. Ecohydrology is about integration of several branches of science. The amount of water, its quality, and some processes in the aquatic environment are guided mostly by climate, but also to a great extent by biotic factors. (Zalewski *et al.*, 1997) This definition shows how important it is to consider all actors, also when considering flooding. A link is already made between policies of sustainable water use and protection and improvement of water quality on one hand and flood protection on the other by integrating the WFD and the FD (see chapter 7). These policies are of great importance in the natural hazard policy framework. Next to the ecological requirements, there is also a need to link social sciences, economic insights, spatial planning, political involvement, etc. A multidisciplinary approach as encouraged in ecohydrology is as crucial in hazard management.

Further within this research it is important to connect flooding with other hazards in a multi-hazard approach. For example earthquakes may trigger landslides which result as flooding in riparian corridors depending on their geomorphologic conditions. Other connections can exist between heat waves and droughts, storms and floods, floods and landslides. Not only floods but also other hazards need to be integrated with relevant sectors such as mentioned above.

Ecosystems can provide many services, mitigating natural hazards is one of them. By neglecting ecosystems such as dunes, floodplains and forests, the vulnerability of adjacent communities can be affected. These ecosystems and others have different values related to

hazard mitigation. An interesting study on this is addressed in the paper “A methodological framework for multi-hazard risk assessment in beaches” where a multi-hazard risk analysis framework was used for beach-ecosystems. This study jointly considers coastal hazards with beach ecosystem services. (Lozoya *et al.*, 2011) The integration of ecosystem services in multi-risk analysis is a field that need be studied further. Increasing opportunities of ecosystems is one of the key issues in ecohydrology. Elimination of threats and amplification of opportunities should be integrated in natural hazard management (see Figure 7). For example a floodplain provides protection for floods but also creates other opportunities such as discharge stabilization in lowland rivers; enhancement of the self-purification of a river, creation of sinks for dissolved pollutants and nutrients. Wetland restoration is another example no only enhancing in-stream retention of water but also contributing to other processes in the biogeochemical cycles. (Zalewski and Wagner-Lotkowska, 2004)



**Figure 7: Maximizing opportunities in a successful strategic scenario of hazard mitigation management (modified from Zalewski, 2004)**

## 9.2 Stages of a policy framework proposal

As presented in the methodology in §9.1, there are 4 stages considered in the policy framework: risk identification, risk assessment, risk management and monitoring and evaluation.

The aim is to build a new framework upon existing legislation and guidelines. An overview is presented below with the most important documents that can be used for each stage. Further it is explained how and why these documents are used for building a new framework.

**Table 4: Guidelines and legislations integrated for a new framework**

MAIN STAGES	SUBSTAGES	GUIDELINES AND LEGISLATIONS
1. Risk identification	a. Data collection	Mapping the impacts of natural hazards and technological accidents in Europe, an overview of the last decade
	b. Scenario building	Principles of multi-risk assessment
2. Risk Assessment	a. Multi-risk mapping and estimation	Armonia
		Principles of multi-risk assessment
		Risk assessment and mapping guidelines for disaster management
	Directive on the assessment and management of flood risks	
b. Vulnerability assessment	Directive on identification and designation of European Critical Infrastructures and the assessment of the need to improve their protection	
3. Risk management	a. Risk manag. plans - mitigation and adaptation plans	Water Framework Directive
		Directive on the assessment and management of flood risks
		Adapting to climate change: towards a European framework for action
		Eurocodes
		Assessing the Potential for a Comprehensive Community Strategy for the prevention of Natural and Manmade Disasters
		Communications
4. Monitoring and evaluating		Water Framework Directive
		Directive on the assessment and management of flood risks

### I. Risk identification

The risk identification stage contains several elements. It must collect historical data on natural hazards that have occurred in the past combined with their impacts. The report “Mapping the impacts of natural hazards and technological accidents in Europe, an overview of the last decade” gives an idea how to collect the data on EU scale. This report gives also advice on data gaps. Long-term data and assessments are crucial to create a solid database. For this the impacts of disasters have to be monitored carefully. The following step is to create hazard identification. This considers all possible hazards, their probabilities of occurrence, their possible interactions with each other and their possible impacts. Scenarios

can be used as a tool to give an idea on what can be expected from disasters in the near future. This is addressed in the guideline “Principles of multi-risk assessment”

## **II. Risk assessment**

Mapping and risk assessment go hand in hand. For example, the FD obligates the MS to set up flood hazard maps and flood risk maps by using a preliminary flood risk assessment. This directive gives potential to link itself with a multi-hazard assessment since flood prone areas might be risky for other hazards as well and some natural hazards can trigger flooding. Both “Risk assessment and mapping guidelines for disaster management” and the “ARMONIA project” are influential documents on multi-hazard mapping.

It is proposed to set up minimum standards in a legal framework (e.g. FD) related to multi-hazard mapping and is recommended to extend the research and prepare a single document as a guideline complementing these standards by providing recommendations on the methods.

Building on the first part, the framework continues with the multi-risk assessment. As mentioned, mapping and risk assessment are closely related. The overview includes 2 important guidelines: “Principles of multi-risk assessment” and “Risk assessment and mapping guidelines for disaster management”. The first presents a new quantitative procedure for multi-risk assessment. The second is rather built on experience, and aims to improve coherence and consistency among the existing risk assessments in the MS. A conceptual framework on multi-risk approach is written down. More information on these guidelines is presented in §5.2. Both contain valuable and different information and could be integrated into 1 guideline for MS to consult.

Besides the risk estimation, the risk assessment also includes vulnerability analysis. Vulnerability must be assessed and then included in the mapping, indicating infrastructures, population, etc. that need protection and sustaining their functioning. The directive on identification and designation of European Critical Infrastructures provides a first step on assessing vulnerable infrastructures and assigning the protection they need. Some key issues from this directive can be integrated in the new framework. The process of identification and designation of infrastructures can be developed into a more broad vision, including a multi-hazard approach and other sectors. The most important issue of this directive is the legal concept including a vulnerability assessment.

### **III. Risk management**

Risk management is about planning with in this research in particular focused on mitigation and adaptation planning. Several documents have important influences on current management practices. The WFD and FD include the river basin management plans and flood risk management plans. The MS are obligated to prepare these plans by following the steps prepared in the directives. They do not provide a detailed description of the plans; only a general overview on how they must be composed and described is given. An important aspect of the directives is that the MS still have a certain freedom on the objectives, implementation, etc. They are generally accepted and in many cases considered as an important step forward. However, a gap in the FD widely acknowledged is the lack of integration with spatial planning, a special attention on that should be brought into the new framework. The white paper “Adapting to climate change: towards a European framework for action” does imply an approach towards integration of spatial planning. An important asset that should be copied from this white paper is its cross-cutting approach; the integration goes beyond any other legally binding documents (related to sectors, authorities and policies). Further it encourages the integration of ecosystem services as mitigation actions and no-regret measures. The Eurocodes contain important technical mitigation actions related to new constructions. They can be used in the new framework and extended to also existing construction mitigation measures and to the effects of multi-hazards. The report “Assessing the potential for a comprehensive community strategy for the prevention of natural and manmade disasters” concludes with a three pillar approach to the EU’s future effort on prevention. These three pillars (see §5.3) are also in this research work considered as necessary developments. Several key issues accord with the objectives of this chapter e.g. the use of EU guidelines. In particular the second pillar, including the development of a new framework approach on disaster prevention includes several relevant concepts. The outline of a future communication and directive on prevention is briefly presented. It also contains an overview of elements which should be included in this new directive. A similar stepwise approach is recommended as in the proposal of this research.

Lastly, several specific communications should be integrated in the new framework considering management actions. The communications addressing droughts and forest fires are important single hazard policies. In the new framework they must be adapted to a multi-hazard approach.

#### **IV. Monitoring and evaluation**

The final step contains monitoring and evaluation. The FD and WFD give an excellent example on updating and evaluating the management plans on a fixed base. This stage is not reviewed in this research work; however it is acknowledged in many studies that the EU should create a monitoring role for updating and performance assessments as a whole. Further research should investigate that role.

##### **9.2.1 *Legal framework***

It is recommended in this research to create a new legally binding framework for multi-hazard risk assessment and management at the EU level. A directive would be the best choice, since it has the most legal influence on EU area. Annex II presents a draft proposal for a directive on the assessment of multi-hazard risks and their mitigation and adaptation management. This draft is set up with the knowledge of this research work and therefore it is not complete. Even though it merely presents a general overview, it can serve as a basic template for a new directive and with more research it can be adapted, extended and improved.

This directive should integrate the policies reviewed in this work. The FD (2007/60/EC) and WFD (2000/60/EC) have been used as example to set up the new directive. This has several reasons: they are directives and therefore legally binding, they are directly related to natural hazard policy, they are widely accepted and they have a great influence in the MS. An important guideline also used for assembling this draft is “Assessing the potential for a comprehensive community strategy for the prevention of natural and manmade disasters” (EC DG Environment, 2008b), which contains an overview of elements important to include in this new directive. These elements are implemented in the proposed draft.

As discussed in this chapter it is proposed to implement a new directive combined with several EU guidelines. These guidelines must contain methodologies, criteria and other information concerning vulnerability assessment, mapping, scenario development, data collection, etc. It is aimed for the directive to set up basic standards in the EU and for the guidelines to assist the MS in achieving those standards.

### 9.3 Conclusions

A new framework is proposed in this chapter, with the aim to create an integrated approach on multi-hazard mitigation and adaptation. First the objectives, key elements and basic methodology are presented. In the methodology there are 4 stages: risk identification, risk assessment, risk management and monitoring and evaluation. The process is explained and for each stage there are several outputs given.

As an important input in this research work, a special attention is given to the role of ecohydrology and ecosystem services related to natural hazard mitigation and multi-risk assessment. A multidisciplinary approach and full integration are key issues. According to the ecohydrology approach, opportunities should be amplified, rather than only focusing on eliminating threats. This concept harmonises with the new approach on mitigating and adapting to natural hazards and should be more highlighted.

It is aimed to build the new framework upon existing legislation and guidelines. Therefore an overview is made on acceptable and useful policies that can be integrated in a new framework. Several documents are linked to each stage of the methodology.

The proposed framework withholds several components. A draft for a directive in Annex II is presented as a legally binding document. The directive sets up basic objectives and standards required from all MS in order to create a higher comparability and cooperation in the EU. Other policies must be integrated in, or linked to, this directive. This document must be accompanied by several official EU guidelines which provide information on methodologies and procedures. In order to assemble these unified guidelines, existing technologies and best practices must be acknowledged and implemented. The existing guidelines mentioned in this work will be the foundation of these new guidelines.

## **10 Recommendations for further research**

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This study must be considered as a preliminary and explorative study. Considering the time and resource limitations, this research work is aimed to be a small step in a comprehensive framework. It is also recognised that several issues have not been identified or assessed in this study. This is for example the case for manmade disasters. Another important issue left out concerns funding and resource limitations. These matters also carry some concerns.

It is advised to continue further research on this issue in particular the creation of a new multi-hazard framework on EU level is crucial. The attention on this matter has increased severely during last years, however still great challenges are recognised. Definitely more studies are required on policy levels. Further it is recommendable to extend the research on ecosystem services, no-regret measures or other opportunities that can be implemented in natural hazard management.



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# Annex I: Overview of the key criteria assessed on all relevant policies

	GOVERNANCE		PARTICIPATION		HAZARD APPROACH					CRITERIA 1	CRITERIA 2	CRITERIA 3	CRITERIA 4	CRITERIA 5	CRITERIA 6	CRITERIA 7	CRITERIA 8	CRITERIA 9	CRITERIA 10	CRITERIA 11	CRITERIA 12
	integrated decision making on all levels	Identification of competent authorities	participation of all stakeholders	information publicly available	multi-hazard approach	hazard identification	vulnerability assessment	risk assessment	risk management	inter-disciplinary	integration	land use planning	mitigation & adaptation								
	steps																				
1	2000/60/EC				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2	2007/60/EC	-			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
3	2008/114/EC	-	X	X	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X
4	COM(2007) 414	X	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
5	COM(2008) 130	X	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
6	COM(2008) 130 Annex	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7	COM(2009) 82	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
8	Council of EU, 2009																				
9	COM(2009) 147 final	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
10	Eurocodes				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

<span style="background-color: green; width: 15px; height: 15px; display: inline-block;"></span>	strived for full implementation
<span style="background-color: yellow; width: 15px; height: 15px; display: inline-block;"></span>	needs to be strengthened
<span style="background-color: red; width: 15px; height: 15px; display: inline-block;"></span>	not present

1	2000/60/EC	Water Framework Directive
2	2007/60/EC	Directive on the assessment and management of flood risks
3	2008/114/EC	Directive on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection
4	COM(2007) 414	Communication addressing the challenge of water scarcity and droughts in the European Union
5	COM(2008) 130	Communication on reinforcing the union's disaster response capacity
6	COM(2008) 130 Annex	Forest fires
7	COM(2009) 82	A Community approach on the prevention of natural en man-made disasters
8	Council of EU, 2009	Council EU: Conclusions on a community framework on disaster prevention within the EU
9	COM(2009) 147 final	Adapting to climate change: Towards a European framework for action
10	Eurocodes	



## **Annex II: Draft proposal for a directive on the assessment of multi-hazard risks and their mitigation and adaptation management**

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### **Chapter 1: General provisions**

#### *Article 1: Purpose*

- The purpose of this Directive is to establish a framework for the assessment and mitigation management of multi-hazard risks, aiming at the reduction of adverse consequences for human health, the environment, cultural heritage and social and economic activity associated with natural hazards in the Community.

#### *Article 2: Definitions*

- Vulnerability, natural hazard, risk, multi-risk, prevention, mitigation, resilience, ...

#### *Article 3: Coordination of administrative arrangements*

- Appointment of competent authorities.
- The date of communication of this appointment to the Commission.

#### *Article 4: Identification of related sectors and all stakeholders*

- Identification process of sectors and stakeholders and outcomes

#### *Article 5: Overall objectives*

- Environmental, social and economic objectives.

### **Chapter 2: Risk identification**

#### *Article 5: hazard identification*

- Required standards for collecting data.
- Review of impacts and past and expected natural hazards.
- Continuous updating and monitoring standards.

#### *Article 6: multi-risk scenario development*

- Development of overall scenarios based on disasters which have occurred in the past, forecasts of inter alia climate change, development trends and other relevant sources.
- Development of EU-wide scenarios which will be addressed through more specific, downscaled based and thematic scenarios.

- Development of scenarios focusing on regional and cross border scenarios.

### **Chapter 3: Risk assessment**

#### *Article 7: Multi-hazard risk identification*

- Preliminary multi-hazard assessment.
- Integrated and cross-cutting mapping of potential risks.
- Potential adverse consequences of future risks.
- Assessment of likelihood and consequences for each scenario.

#### *Article 8: Vulnerability assessment*

- Identifying and designation of critical infrastructures (2008/114/EC)
- Overview of parameters and characteristics for vulnerability and existing resilience.
- Standards and objectives for vulnerability assessment.

#### *Article 9: Multi-risk mapping*

- Required standards for multi-hazard risk mapping.

#### *Article 10: Multi-hazard risk assessment*

- Process to obtain an estimate of risk of each adverse event and of multi-risk.
- Comparison of multi-risk value with criteria.

### **Chapter 4: Risk management**

#### *Article 11: Integration of stakeholders, identified authorities and related sectors*

- Coordination between sector plans.
- Coordination and meetings of stakeholders.
- Coordination of authority levels.

#### *Article 12: Integration of ecosystem services*

- Research and identification of new networks which can provide information on ecosystem services.
- Procedures to recognise and set up the integration of ecosystem services.
- Proposals to actions, coordination and assessment.

*Article 13: Integration other community goals*

- Research and identification of new networks which can provide information on community goals.
- Procedures to recognise and set up the integration of the community goals.
- Proposals to actions, coordination and assessment.

*Article 14: Proposal for mitigation and adaptation actions*

- Objectives to set up and coordinate actions.

*Article 15: Assessing the actions on cost-benefit analysis*

- Required standards on cost-benefit assessments (environmental, economic and social issues) on proposed actions.

*Article 16: Mitigation and adaptation plans*

- Implementation of actions.

*Article 17: Risk management plans*

- Required standards and outputs.
- Integration of prevention, preparedness, response and recovery
- Coordination of cross-border action plans.

**Chapter 5: Coordination with other policies, public information and consultation**

- Integration of actions and plans with other policies and objectives.
- Active involvement of all interested parties
- Information available to the public

**Chapter 6: Implementing measures and amendments**

- Technical formats and data transmission
- Adaptations according to scientific and technical progress

**Chapter 7: Transitional measures**

- Referring to assessments, actions, etc. already existing and equivalent to the requirements can be integrated and stayed in place.

## **Chapter 8: Monitoring, reports and final provisions**

- Performance indicators and monitoring for the assessment of the overall management plan.
- Reporting to the EU Commission on risk identification, risk assessment and risk management.
- Reviews, updates and feedback.

### **Annexes of the directive:**

The annexes must contain general overviews for contents and procedures for management plans, risk assessment, designations and identification processes, etc. (cfr. Annex of the FD (2007/60/EC) which contains the components and description of the implementation of the flood risk management plans).