Project 1.3.1
The spatial effects and management of natural and technological hazards in general and in relation to climate change

1st Interim Report, March 2003

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1 PART I

SUMMARY WITH MAIN FINDINGS

1.1 Definitions

One of the main findings concerned the need for appropriate definitions of terms in the project. This was revealed during the discussions held at the kick off meeting in January 2003. The main concern of definition is among the terms "hazards" and "risks". According to a discussion in the chapter below, which is based on international literature review, the concept of *hazards* appears to be more general than the more specific concept of *risks*. While *hazard* is defined as "a condition or situation that could lead to harm" *risk* concepts are better suited for taking human influence into account and also better for operationalization of research. An important implication for the project is the adoption of an *ex-ante* risk management perspective. The project provides a glossary where the most important terms used are explained. The title of the project speaks about "*hazards*" only but in conclusion of the glossary the project will also make use of the term "*risks*".

1.2 Indicators

Several hazard and risk oriented indicators exist on European and international level. The project is mostly concerned about finding data sets for indicators that can be applied on a pan-European basis and to develop indicators on data sets that do not (yet) cover all of Europe. The project will recommend such indicators because they are of environmental and political importance. Their introduction could animate those regions, were data is not yet available, to start to collect relevant information. This concerns e.g. the record of oil spills from tankers.

One of the main focuses in the development of indicators lies on *Response* indicators. A review of EEA and JRC indicators has shown that among the DPSIR chain most indicators represent *State* and *Impact*, a few *Pressures* and very few *Driving Forces* and *Responses*. Hence this project deals with hazards and risks, mitigation appears to be one of the prime issues of relevance and those are best represented by *Response* indicators. Regarding the defintions of the term”response”, please see chapter 2.4 *Glossary.* Concerning a typologisation of indicators and Regions, a first comprehensive list of indicators as well as first drafts for a synthetic index of vulnerability, please see chapter 6 *Further Investigations* for more information.

1.3 Case study areas

The project was told during the lead partner meeting in Brussels in February 2003 that case study areas do not belong to the prime goals of the action 1.3.1. Nevertheless, case study areas are a great help in the identification of how hazards and risks are dealt with in practice. The project has identified five case study regions with different kind of problems and advances in hazard mitigation (Central

Region of Portugal, Region of Dresden in Germany, Itä Uusimaa in Finland, Andalusia in Spain and a region still to be determined in Switzerland). The case study areas are used for comparison and for the determiantion of best possible practices on how hazards are manageable. Together with the typologisation of hazards and regions, as well as indicator and map development, this will lead to concrete policy recommendations for spatial planning on how to focus on technical and natural hazards on a European wide basis. Please see chapters 4.4 and 5.4.3 for more details on the relevance of case study areas.

1.4 Networking undertaken towards other TPG

The networking towards other TPG's was just recently started because the main focus of the project lies on the production of the first report, due only 3 months after the project's start. Contatcs were taken towards project 3.1 and comments given to their list of indicators. 1.3.1 offered the iniative to send our first interim report to all the other projects as a start for networking. 3.1 welcomed this idea. The networking will be intensified once the first report is submitted because then the project can already show what has been done so far and what kind of cooperation could be useful for other projects.

The TPG 1.3.1 was enlarged by Swiss Federal Institute of Technology Lausanne (EPFL), Laboratory of Engineering and environmental geology (GEOLEP). This institute will provide its own budget and assist in the reporting. It will contribute mainly with case study examples from Switzerland.

1.5 Updated information on preliminary results and maps envisaged for ther interim report in August 2003

The project had its kick off meeting in mid January, 2003 during which the detailed work plan for the first reporting period was decided. Since the kick off meeting the project partners have prepared their input to the first interim report that should be ready at the end of March, 2003. Because the first interim report is still unfinished the first outline of results and maps envisaged for August, 2003 (the second interim report) is based on the project tender. The expected outcome of the report will be clarified in greater detail, based on the achieved results and feedback from project 3.1 and the Espon Coordination Unit.

1.6 Envisaged contents of the 2nd interim report for August 2003

a) List of existing hazard related indicators
   - Indicators from the EEA, EuroStat, Joint Research Centre and EuroGeoSurvey
   - Specific hazard related indicators from British Geological Survey (BGS) and The International Atomic Energy Agency (IAEA)

b) The selection of the specific indicators to develop risk maps
   - The risk maps are useful for the risk prevention into the spatial planning
   - The risk maps can be used to determine which still existing sensitive land uses are situated in areas with a high risk of hazards

c) First versions of European wide risk maps based on the existing hazard indicators

d) Examination of the EU-level indicators that are more abstracted have a regional utilization (scale 1:50.000-100.000)

e) Examination of risk indicators on regional level in case study areas and, if possible in EU NUTS3 level
   - Volcanic eruptions
   - Floods
   - Landslides / avalanches
   - Earthquakes
   - Droughts
   - Forest fires
   - Storms
   - Extreme precipitation
   - Extreme temperatures
   - Hazards from nuclear power plants
   - Hazards from production plants with hazardous production processes or substances
   - Hazards from hazardous waste deposits or the storage of nuclear waste or mining stockpiles
   - Hazards from marine transport of hazardous goods

f) Development of risk indicators with applicability to a regional scale
   - First versions of risk maps in selected pilot areas

g) First list and map of spatial typology of risks in Europe

The following points are adressed in a first approach in the part II of this report, chapter 6. "Further investigations"

- Synthetic index of vulnerability
- Compilation of good practices in the management of natural and technological risks
- 2 typologies of regions
- First proposals to improve monitoring systems for natural and technological hazards

The further development of the above mentioned points will lead to ideas and draft guidelines on spatial planning for natural hazard risk reduction.

2 PART II

BACKGROUND AND OBJECTIVES

The overall goal of the ESPON 1.3.1 Action is to analyse the spatial effects and management of natural and technological hazards. As a first step towards developing an appropriate methodology for assessing these hazards it is necessary to have a common and consistent terminology. This requires a thorough understanding of key concepts in order to reach agreement on common definitions. Therefore this Technical Note identifies and discusses relevant concepts and proposes operational definitions for the use within the project.

2.1 Concepts

There are many, partly overlapping or even conflicting concepts that are relevant when dealing with 'hazards'. This section aims to clarify and discuss the major concepts and their interrelations. The concepts can be grouped as follows: A first group of concepts revolves around *dangers* (hazard, risk), the second deals with *impacts* (damage) the third and fourth with the *perception and analysis* and the *management* of risks, whereas the final group of concepts is concerned with *vulnerability*.

2.1.1 Danger concepts

There are two commonly used concepts that both deal with potential dangers, namely hazard and risk. A **hazard** can be defined as *"a potentially damaging physical event, phenomenon or human activity, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation"* (UNISDR 2002, 24-25). UNISDR further specifies that *"[h]azards can be single, sequential or combined in their origin and effects. Each hazard is characterized by its location, intensity and probability"* (ibid.). The UNISDR (2002, 24-25) defines **risk** as *"the probability of harmful consequences, or expected loss (of lives, people injured, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human induced hazards."*

A common way to highlight the differences between risks and hazards is to stress their natural versus their anthropogenic element. Hazards are commonly understood as possible natural events with detrimental consequences whose causes are beyond human control. A typical example would be an earthquake. On the other hand risks would relate to dangerous situations caused by human activities, e.g. the meltdown of a nuclear reactor. Following the above definitions, this simple juxtaposition of hazards and risks based on the distinction between natural and technical dangers cannot be upheld, though. While it is true that humans in general have no influence on the occurrence or magnitude of earthquakes, to live or work in an earthquake-prone area is a more or less conscious decision. Because of this deliberate exposure one could in this case speak of a conscious risk that is based on a natural hazard. Furthermore, today we understand, that many seemingly 'natural' hazards, such as river floodings, have a strong human causative element, e.g. through the straightening of rivers.

This shows that both concepts are not mutually exclusive. Risks can be seen as “domesticated” hazards. The hazard concept stresses possible impacts of events on individuals, groups or communities and refers to a potentially damaging disaster. The risk concept emphasizes possibilities for active management (avoidance or mitigation) of harmful events and therefore renders hazards calculable and manageable. Consequently, there is an important division of work between the two concepts: In sum, hazard refers to an event and risk to its probability (and to a range of methodological implications e.g. risk analysis and management).

2.1.2 Impact concepts

The concepts discussed in this subsection describe different aspects of the impact of a realised hazard. ***Damage*** can be defined as the amount of destroyed or damaged property assets, cultural assets, the environment as well as the physical and psychological injury of people as a consequence of an occurred hazard. This general and wide definition may be accepted by most experts and stakeholders. However, there is less consensus when it comes to specifying what exactly counts as damage and what does not – not least because this determines the amount of insurance and reparation payments. Three critical aspects can be identified:

Degree aspects: Three types of damages can be differentiated, namely direct damages to assets or persons, indirect damages due to lost or impaired benefits in the present or future (e.g. long-term job loss due to physical disability) and damages as lost benefits due to the costs of reconstruction or replacement of damaged assets.

Temporal aspects: Of relevance are first the temporal cut-off line beyond which the long-term impacts of an occurred hazard are not taken into consideration anymore, and second the issue of temporal discount rates, i.e. how immediate damages are weighted in relation to long-term damages. Both aspects also touch issues of sustainability and intergenerational justice.

Measurement aspects: Some damages can be more easily quantified than others (e.g. economic damages compared to environmental or psychological damages). Also, when it comes to integrating the various kinds of damages to arrive at a value for the total damage of an event, the question of how to weight these different damages arises.

The *damage potential* is defined as the maximum amount of damages that can possibly occur in an area due to human activities or natural events. In other words, the damage potential is equal to the complete destruction of all assets and the death of all inhabitants of an area.

2.1.3 Risk evaluation concepts

A risk management process starts with the identification of the relevant hazards and their consequences, in particular the magnitude and the probability or frequency of consequences. On this basis a ***risk assessment*** can be done. A human being regularly performs numerous simple, more or less intuitive risk assessments every day in order to be able to make some sort of judgment about the risk relating to a particular action. Simple examples are safety risks like crossing a road, health risks like smoking and financial risks when buying a car or a house. Risk assessment as a formal step within a risk management process should be carried out in advance of an action. The quality of any risk assessment is determined by the extent of knowledge of intended actions and their effects.

The first step of a risk assessment is the ***risk estimation***, which is concerned with the outcome or consequences of an intention taking also into account the probability of occurrence. Risk estimation itself is in reality always subjective because the precise and full knowledge necessary for a truly objective risk estimation is rarely available (e. g. full information about frequency and magnitude). Therefore decisions are often taken in response to pressures generated by perceptions of risk.

As regards ***risk perception*** it should be noted that sometimes those who have not studied the relevant statistics base their perception of certain risks on a significantly "incorrect" (from a statistical perspective) judgement of the probabilities of potentially hazardous events (so called heuristics). But risk perceptions are a fact of life that shape, for instance, policy, legislation and mitigation efforts and therefore can be seen as incorporated in norms, practices and probability calculations. There are many factors known to affect an individual's perception of risk, namely familiarity with a risk, control over the risk or its consequences, proximity in space, proximity in time, scale of the risk or general fear of the unknown (the so called dread factor). Apart from these factors, individual risk perception is also shaped by how the community or a certain socio-cultural milieu is dealing with a special type of risk or risky situations in general. An important and interesting aspect of risk perception is the variation in different cultural (regional, national) contexts, a perspective studied within the cultural risk paradigm (e.g. Douglas 1966, Douglas & Wildavsky 1982). Risk perception enters the risk management equation through differing estimations on how probable an event may be, how much money is to be spent on preparedness etc. Furthermore, individual risk perceptions are to be distinguished from the way "institutions think" (Douglas 1986).

2.1.4 Risk management concepts

For ***risk management*** two different definitions are in common usage. The first definition focuses only on the process of implementing decisions that aim at tolerating or altering risks. The second definition is broader and defines risk management as the systematic application of management policies, procedures and practices of identifying, analysing, assessing, treating and monitoring risks. Especially relating to natural hazards the term disaster response is also common and has a similar meaning as risk management. Disaster response or risk management consists of four stages:

Mitigation: The reduction or elimination of long-term risk to human life and property from any kind of hazard that takes place well before the disaster occurs. Typically carried out of a co-ordinated mitigation strategy or plan. One can distinguish four basic approaches of mitigation:

Structural mitigation: This includes the strengthening of buildings and infrastructure exposed to hazards (e. g. engineering design, building codes, dams) as well as building protective structures (e. g. dams or seawalls).

Nonstructural mitigation through impact reduction: This mitigation strategy aims to reduce the impacts of hazards, e.g. by maintaining protective features of the natural environment that absorb or reduce hazard impacts (e. g. natural flooding areas, sand dunes).

Nonstructural mitigation through avoidance: This mitigation strategy aims to avoid hazardous areas, e.g. by directing new development away from known hazard areas through land use planning or relocating existing developments out of hazard-prone areas through financial incentives or high insurance premium.

Prevention oriented mitigation aims to reduce the influence of the driving forces of hazards and damage potentials (e. g. activities to reduce greenhouse gas emissions or changes towards more sustainable lifestyles) which are closely linked to climate change.

Preparedness: This means short term activities, such as evacuation and temporary property protection, undertaken when a disaster warning is received.

Response: This term indicates short-term emergency aid and assistance, such as search-and-rescue operations, during or following the disaster.

Recovery: This constitutes the last step of post disaster actions, such as rebuilding or retrofitting of damaged structures.

While mitigation is characterised by long-term actions, the last three points (preparedness, response and recovery) aim at short-term actions in case of an occurring disaster and therefore can be subsumised under the term of ***reaction***.

The effectiveness of disaster response or risk management, respectively, depends on the ***coping capacity***. The notion of capacity refers to coping capabilities and clearly points towards "institutional preparedness". According to the UNISDR definition, capacity refers to "*the manner in which people and organisations use existing resources to achieve various beneficial ends during unusual, abnormal, and adverse conditions of a disaster event or process. The strengthening of coping capacities usually builds resilience to withstand the effects of natural and other hazards*". To a large extent, coping capacity includes "institutional preparedness" which is considered to be one of the main aspects how spatial planning deals with hazards and risks. The strengthening of coping capacities usually builds **resilience** to withstand the effects of natural and other hazards.

2.1.5 Vulnerability concepts

In a narrower meaning, ***vulnerability*** can be defined as the total damage potential of an area multiplied by the average degree of impact to be expected in this area. This average degree of impact is also referred to as ***relative vulnerability***, which is determined by the potential of a community to react and withstand a disaster, e. g. its emergency facilities and disaster organisation structure. In a broader way, vulnerability is defined as a "*set of conditions and processes resulting from physical, social, economical and environmental factors, which increase the susceptibility of a community to the impact of hazards*" (UNISDR 2002, 24). Thus the vulnerability concept points to the human factor of disasters. To understand what makes a community vulnerable one has to take into consideration a wide range of economic, social, cultural, institutional, political and psychological factors.

In short, three different views and resulting strategies to address vulnerability can be distinguished:

Nature as cause: According to this view nature and natural hazards are the cause of people's vulnerability, which fluctuates according to the intensity, magnitude and persistence of occurred events. To reduce vulnerability, systems for predicting hazards, and technologies to enable infrastructures and settlements to withstand negative impacts are designed and applied (equipment to monitor seismic activity, weather forecasting, remote sensing for drought and fire monitoring, water control systems, building code regulations, etc.). Preferred strategy: object and event oriented technological and juridical solutions.

Cost as cause: In spite of increasing technological and scientific capacity, people continue to suffer, because prediction and mitigation technologies are costly. Economists develop and still improve methods to assess the costs of losses from disasters to calculate whether, when, how and where reducing vulnerability is efficient and feasible. In this view, vulnerability will be reduced if national governments are willling to invest in safety nets and insurance. Preferred strategy: economic and financial solutions.

Societal structures as cause: Disasters have differential impacts on people who live in hazard-prone areas. It is not only the exposure to hazards that puts people at risk, but also socio-economic and political processes in society that generate vulnerability. These create the conditions that adversely affect the ability of communities or countries to respond, to cope with or recover from the damaging effects of disaster events. These conditions precede the disaster event, contribute to its severity and may continue to exist even afterwards. In this perception, a safer environment ("disaster resilient communities", Burby et al. 1998) can only be achieved if disaster response changes the processes that put people at risk. The long-term solution lies in transforming the social and political structures. Preferred strategy: multiple political solutions that includes spatial matter.

2.1.6 Relation of concepts to each other

An important basis for the identification of relevant components within the concepts discussed above and for their operationalisation is the clarification of their relation to each other. A first general way of distinction is the temporal perspective. When talking about extreme events, damage or disaster this describes the end-result of a causal chain of events. This "ex post" perspective is illustrated in the following Figure 1.

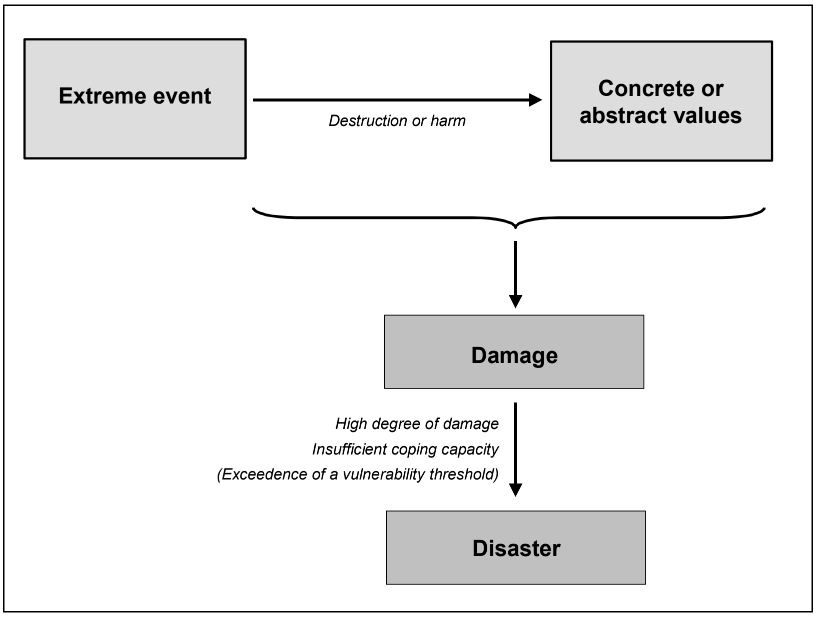

Figure 1: Events and disasters: the ex post perspective
Source: Fleischhauer 2003

As the main focus of the ESPON Hazards project is on monitoring of risk components with the goal of avoiding the occurrence of disasters or at least the reduction of their impacts, an "ex ante" perspective is appropriate. In this context the terms of hazard potential, damage potential, prevention and response potential, vulnerability and risk are used as shown in Figure 2.

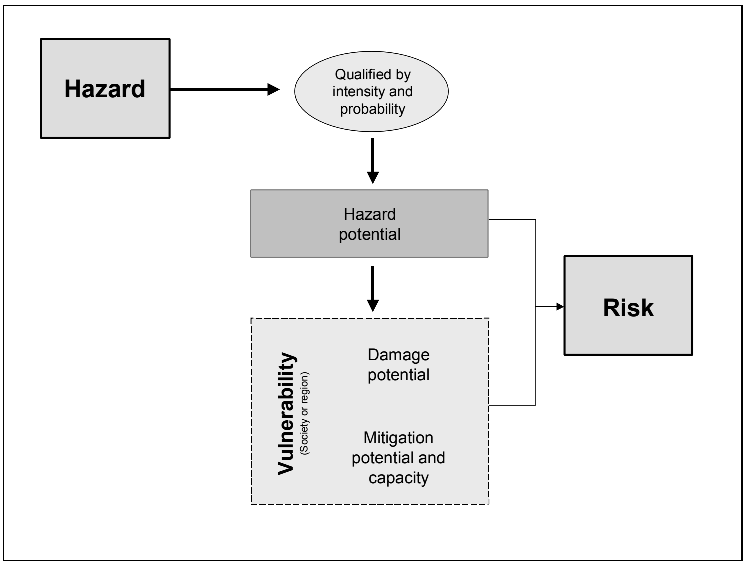

Figure 2: Hazards, vulnerability and risk: the ex ante perspective
Source: Fleischhauer 2003

As there are different definitions of vulnerability, some authors define risk as the result of a hazard multiplied by vulnerability divided by capacity. In this case, damage potential is integrated in the hazard potential as a degree of the intensity of a hazard. Other authors suggest to clearly separate the components of damage potential on the one hand and coping capacity on the other hand as shown in the above figure. We would suggest to follow this definition as we believe (and that is how it is outlined in the tender) that only a monetary based index of risk will be feasible in the project. As hazard potential and damage potential can be expressed by ordinal scales this will likely not be possible for the coping capacity because of methodological reasons and maybe the lack of data. Therefore we think that it will be necessary to separate hazard potential, damage potential and coping capacity from each other. Coping capacity should then flow into the project in a qualitative way. Vulnerability will then be understood as a combination of damage potential and coping capacity and also will be expressed only in a qualitative way. This would then lead to the following formula:

Risk = Hazard potential x Damage potential / Coping capacity,

or:

Risk = Hazard potential x Vulnerability

(Blaikie et al. 1994, 23).

This formula seems useful in building the logic between the concepts we use. In relation to the UNISDR definition, this conceptualisation corresponds to the definition of hazard potential characterised by its probability (= frequency) and intensity (= magnitude).

Following this logic, we can add to the previous formulation, defining an overall risk in a given location as:

Risk = Hazard potential (Probability x Magnitude) x Damage potential / Coping Capacity

Following such an equation we can, for example, have a probability (e.g. once every 200 yrs.) for an event (e.g. a flood) the magnitude (height of water level), the damage potential (possible economic or social damage or loss) which will be alleviated by response actions like mitigation and reaction measures which are in their quality determined by the coping capacity (e.g. by poverty, lack of insurance, lack of relief schemes and early warning systems, competent planning efforts, self-help networks and "social capital" etc.).

2.2 Implications for the project

What follows from the above discussion is that the ***risk concept*** is the appropriate approach when taking into account the formulation of planning responses to hazards. Lastly it provides the conceptual ground for human coping strategies (e.g. a spatial planning response) and is thus more compatible with the risk management concepts discussed in sub-section 2.1.4. Therefore the risk management perspective will be favoured although the hazard concept will not be discarded. Within the ESPON Hazards project we refer to the hazard concept whenever the hazard as such is in the main focus. The term hazard will be understood mainly as the very first step of a risk management process, which analyses the characteristics of a threat (frequency, magnitude). When the *management of hazards* is in the foreground, we will refer to the risk concept.

Regarding the discussion of ***damage, vulnerability*** and ***risk perception***, it is a matter of fact, that there is no common understanding. Nevertheless it is indispensable to be aware of the vulnerability of threatened people and their perception of this vulnerability. Certainly this aim is of importance on a local level and even more so on a concrete, project oriented level. On these levels, it is necessary and possible to include the differences in risk perception, to use a very broad damage concept and to be aware of the individual view on vulnerability of the affected people. For integrating these aspects qualitative empirical studies are indispensable. However, this is impossible to fulfil on an European-wide level. The aim of this ESPON project is to identify high risk areas and to create a synthetic index of vulnerability. Therefore we should use very narrow definitions which fade out the differences in the perception of risk and vulnerability and take into account only those damages, which could be quantified in monetary terms.

Regarding the concept ***risk management*** the discussion made clear that this concept goes beyond the DPSIR framework (driving forces, pressures, state, impact, response) mentioned in the tender. Although the DPSIR framework was originally built for reporting on environmental issues (EEA 1999: 6) it can also be applied to spatial risk issues. Therefore it was proposed in the tender that in this ESPON project response indicators would refer to responses by the response network to prevent, compensate, ameliorate or adapt to changes in the state of "spatial security" (the opposite term to "spatial risk"). From the broader viewpoint of risk management this means that the risk management stages of prevention, mitigation, preparedness, response and recovery should be incorporated into the DPSIR chain link of 'response'. Therefore the following figure presents the concepts proposed in this Technical Note in relation to the chain links of the DPSIR framework:

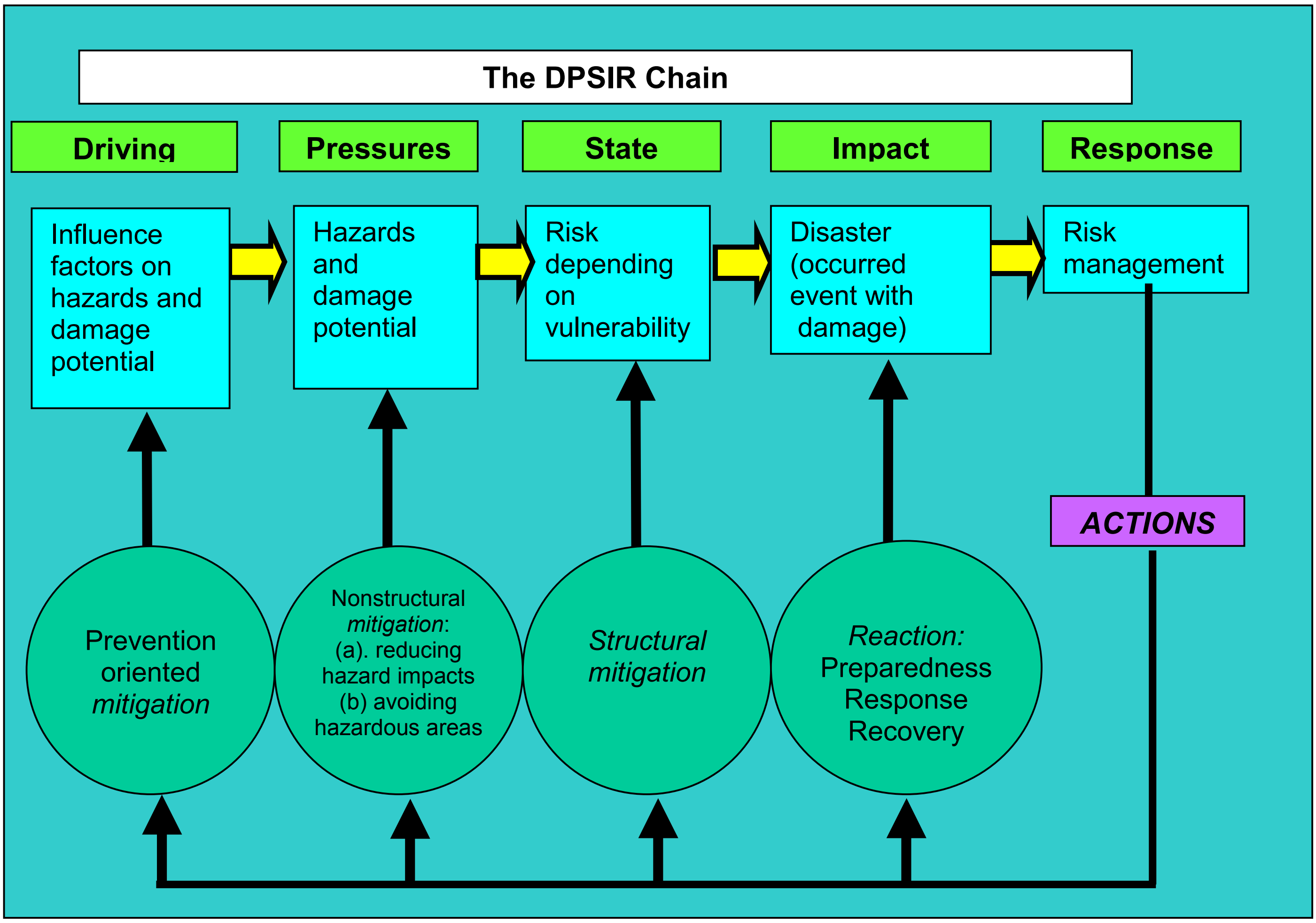

Figure 3: The proposed ESPON Hazards concepts in relation to the DPSIR chain

2.3 Further Questions

Yet, there are further questions that are not answered yet and that have to be discussed beyond the 1st Interim Report:

An important further consideration is how to make the concepts operational.

- What kind of data is available/needed that reflects different terms in the risk equation presented in the conceptual discussion above? (what data on hazard probability? what data on hazard intensity & damage potential? what data on vulnerability? what data on coping capacity & mitigation efforts? etc.)

- On the other hand we should ask what the data tells us? For instance, what is population density or construction density a measure of? What are the limits of monetary valuation? (note, for example the clear difference between rich and poor countries in terms of loss of lives due to disasters: poverty and other vulnerabilities lead to loss of lives with relatively little damage in monetary terms. In Europe the opposite holds: little lives lost, but monetary losses are large). Such issues in data limitations should be included in the form of a discussion, combined with observations from case study areas.

- Studying individual risk perceptions are of limited interest in the project but some survey data on this issue could provide a backdrop for the vulnerability index. Institutional risk perceptions are more interesting, while they infliuence the assessing of risk (hazard probability) or determining the preparation level to a flood (1/50yrs... 1/1000yrs.) may reflect shared risk perceptions.

2.4 Glossary

Coping capacity: Capacity refers to the manner in which people and organisations use existing resources to achieve various beneficial ends during unusual, abnormal, and adverse conditions of a disaster event or process. The strengthening of coping capacities usually builds resilience to withstand the effects of natural and other hazards.

Damage: The amount of destroyed or damaged property asset, the injury of people and environment as a consequence of an occurred hazard.

Damage potential: The amount of property asset in a threatened area.

Disaster: A hazard might lead to a disaster. A disaster by itself is an impact of a hazard on a community or area – usually defined as an event that overwhelms that capacity to cope with.

Exposure: The amount of substance ingested, the amount in contact with the skin or either the amount inhaled or the concentration in the atmosphere.

Hazard: A property or situation that in particular circumstances could lead to harm. More specific, a hazard is a potentially damaging physical event, phenomenon or human activity, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Hazards can be single, sequential or combined in their origin and effects. Each hazard is characterised by its location, intensity and probability.

Losses: The amount of realized damages as a consequence of an occurred hazard.

Mitigation or disaster mitigation: A proactive strategy to gear immediate actions to longer-term goals and objectives.

Preparedness: This means short term activities, such as evacuation and temporary property protection, undertaken when a disaster warning is received.

Reaction: While mitigation is characterised by long-term actions, reaction aims at short-term actions in case of an occurring disaster. Reaction comprises preparedness, response and recovery.

Recovery: This constitutes the last step of post disaster actions, such as rebuilding or retrofitting of damaged structures.

Response: Regarding the term of "response" we have to distinguish between three different meanings:

as an element within the DPSIR chain,

in a general meaning as a spatial planning answer as proposed in the tender

as a narrower term which describes specific reactions immediately after a disaster has occurred.

Response in the broader sense means the sum of long-term actions (mitigation in terms of planning responses) and short-term actions (reaction) to prevent disasters or mitigate their impacts. In this sense it is linked to the Response chain link of the DPSIR chain. In a narrower sense, response is a part of short-term actions (reaction) when a disaster occurs. In this sense, response means short-term emergency aid and assistance, such as search-and-rescue operations, during or following the disaster.

Risk: A combination of the probability or frequency of occurrence of a defined hazard and the magnitude of the consequences of the occurrence. More specific, a risk is defined as the probability of harmful consequences, or expected loss (of lives, people injured, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human induced hazards.

Risk analysis: Risk analysis is the mathematical calculation which includes the analysis of a hazard (frequency, magnitude) and its consequences (damage potential).

Risk assessment: Risk assessment consists of risk estimation and risk evaluation.

Risk estimation: Risk estimation is concerned with the outcome or consequences of an intention taking account of the probability of occurrence.

Risk evaluation: Risk evaluation is concerned with determining the significance of the estimated risks for those affected: it therefore includes the element of risk perception.

Risk perception: Risk perception is the overall view of risk held by a person or group and includes feeling, judgement and group culture.

Vulnerability: Vulnerability is the degree of fragility of a person, a group, a community or an area regarding to defined hazards. In a broader way, vulnerability is defined as a set of conditions and processes resulting from physical, social, economical and environmental factors, which increase the susceptibility of a community to the impact of hazards. Vulnerability is determined by the potential of a community to react and withstand a disaster, e.g. its emergency facilities and disaster organisation structure (coping capacity).

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3 UPDATED WORK PLAN FOR WORK PACKAGE 3: APPLICATION OF INDICATORS TO SPATIAL PLANNING, APPLICABILITY TESTING

This workpackage applies the proposed indicators to spatial planning and tests these indicators on a regional scale. The indicators related to natural hazards together with technological hazards will be compared to spatial planning issues and their utilization in planning process will be discussed. The DPSIR concept plays a major role in these discussions.

WP-leader: IOER

Participating partners: CCRC + IGM

Participating case study areas: DD2, Central Rion of Portugal, Itä Uusimaa, Andalucia, a region in Switzerland (to be selected).

3.1 Aims and objectives

3.1.1 Selection of specific indicators for the development of risk maps

The selection of the specific indicators to develop risk maps are useful especially for the risk prevention into the spatial planning. Therefore the spatial planning should control the sites for settlement areas or rather should exclude particular land uses in sensitive or endangered areas for example chemical industry in flood zones. In this way spatial planning is able to decrease the risk potential in case of natural or technical hazards.

Additional to the strategy of "risk prevention" the risk maps can be used to determine which still existing sensitive land uses are situated in areas with a high risk of hazards. An example for this is to show if hotels are situated in sloping sites with avalanche danger.

Danger (hazard) maps are detailed maps indicating the spatial distribution of danger of different hazards in including the category (type), intensity and periodicity of danger and may thus differentiate several danger zones at the local level.

Risk maps are detailed maps indicating the spatial distribution of potential damage, a hazard may cause in dependency of its category, intensity and periodicity. They may differentiate several risk zones at the local level.

Danger reference maps are general maps at a regional level indicating potential danger that has been recognized at certain areas but which has not yet been analysed at the local level thus preparing further (local) spatial investigations.

In these cases the risk maps can be a base to decrease the risk potentials subsequently for example by fixing alternative sites for endangered uses.

To work out the risk maps and to make them available for the spatial planning it's necessary to develop indicators which

- include spatial aspects such as dimension and distribution
- differentiate the risks of damages for the particular hazards. For example areas which are endangered by avalanches can be protected by afforestation. The afforestation could decrease the risk potential of settlement areas near by, too. In comparison to reduce the effects of an accident in an atomic power station a safety zone without settlement areas should be kept free around the power station. In this case an afforestation would be no protecting measure

The working steps for the „selection of specific indicators for the development of risk maps“ are

- Analysis of the indicators worked out in work package 1 and assignment to specific hazards
- Examination if the EU-level indicators which are more abstracted have a regional utilization (scale 1:50.000-100.000)
- if necessary differentiation of the indicators to ensure their utilization for the regional spatial planning

Reference:

BUWAL (Hrsg.) (1998): Methoden zur Analyse und Bewertung von Naturgefahren. - Umwelt-Materialien Naturgefahren, Nr. 85, Bern.)

3.1.2 Examination of the applicability of risk indicators to a regional level (Examination in case study areas)

Herewith the indicators should be tested for suitablility for the spatial planning practice. The selection of case study areas must ensure, that there

- is a wide variety of natural and technical hazards so that a great number of specific risk indicators could be tested (mix between natural and technological hazards, eg. Floods, contamination of aquifer, uranium mining, chemical industry, fire, coastal erosion)
- are different prerequisites for the spatial planning. It' s to trace if a different precision or obligation of the spatial planning could cause other strategies of risk prevention. Knowing the differences between the spatial planning in the EU-member-states the indicators have to reflect this characteristics

Working steps for the „examination of risk indicators on regional level in case study areas“ are

- Selection of case study areas with a wide variety of hazards and a different spatial planning system/planning methods
- Evaluation of regional plans in the case study areas aspecting the utilization of risk indicators (same/different kind of indicators)
- Interview of the administrations which are responsible for the spatial planning to find out their acceptance of presently not used but possible risk indicators (indicators out of work package 1)

Results of the second working step should be

- differentiation of the selected and if necessary detailed risk indicators in
- approved and in the spatial planning already used risk indicators
- risk indicators which will be an efficient addition to the spatial planning
- risk indicators which are classified as „actually not usable for the planning practice”

With regard to the disposal of data, knowledge of regions and contacts to administrations Central Portugal and South-Eastern Germany (Saxony) should be the case study areas. They will be completed /supplied with special case study regions, such as Itä Uusimaa, Andalusia and a region in Switzerland. In the case study areas an additional and more detailed analysis of spatial plannings is possible for specific hazards. These specific hazards will be examined for example in Switzerland (avalanches, moraines) and Southern Finland (atomic power station, refinery).

3.2 Timetable and milestones

December 2002 – March 2003:	Selection of the case study areas and data request
March 2003:	Input to first interim report
April – August 2003:	Analysis of existing regional plans and risk plans in the case study areas and interview of the administrations that are responsible for the spatial planning to find out the acceptance of risk indicators
August 2003:	Input to second interim report
September 2003 – January 2004:	Assessment of the risk indicators and their utilization in spatial planning
January 2004:	Input to third interim report
February 2004: – August 2004:	Further case studies to enlarge the examination
August 2004:	Input to final report

3.3 Outputs

- development of risk indicators with applicability to a regional scale
- valuation of the application of risk indicators to spatial planning
- proposal of an operational risk indicator set to optimize risk prevention in the field of spatial planning
- contributions to reports

4 DATA AND INDICATORS

Database and GIS platform

The ESPON database must be seen as a spatial indicator base using the official statistics of the statistical offices of the European Community, the Member States and other European countries as well as of other sources. Project 3.1 will provide to TPGs (Transnational Project Groups) components for analysis and spatial visualization including common map design. The core of data and indicators in database should be made available on NUTS3 level.

All previous mentioned items will be collected in internet-based and centrally built GIS platform by project 3.1. In addition a French research group called *Hypercarte Project* will provide a set of analysis tools in form of *ESPON Hyper Atlas*. The ESPON Hyper-Atlas is an application of selected spatial analysis tools dedicated to the European databases. These Hyper Atlas tools will be analyzed by the TPGs in framework of the ESPON 2006 program.

The basic territorial units for statistical analysis on NUTS levels has been received on February 2003 as well as the ESPON map design.

Indicators

An indicator is a tool to measure and indicate the development of various phenomena. It shows the condition of a system and changes over time. One of the main tasks of this project 1.3.1 is to study and make an assessment of existing and proposed indicators related to natural and technological hazards. There are discussion and assessment of the possible useful indicators in following chapters. The project 3.1 has also provided a list of core indicators and typologies to be used in ESPON projects. Project 1.3.1's comments about these indicators have been sent to ESPON coordination unit on 7.3.2003.

4.1 Eea Indicators Studied for the Espon Hazards Project

The European Environment Agency EEA

The EEA aims to support sustainable development and to help achieve significant and measurable improvement in Europe's environment through the provision of timely, targeted, relevant and reliable information to policy making agents and the public.

http://www.eea.eu.int/

The European Environment Agency's core task is to provide decision-makers with the information needed for making sound and effective policies to protect the environment and support sustainable development.

The Agency ensures this information is available to the general public through its publications and its website. The EEA does not make or enforce European Union environment policy or legislation: this is the responsibility of the European Commission and the other EU institutions.

The information provided by the EEA focuses in particular on assessing the current and future state of the environment across Europe and the pressures upon it. The Agency's tasks also include disseminating best practice in environmental protection and technologies, and supporting the European Commission in diffusing information on the results of environmental research.

The Agency both gathers and distributes its data and information through the European environment information and observation network (EIONET), which brings together just over 300 environment bodies, agencies, public and private research centres and centres of expertise across Europe. The EEA is responsible for coordinating the EIONET.

Current EEA member countires are:

- The 15 European Union Member States
- Iceland, Norway and Liechtenstein, which are members of the European Economic Area
- Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Romania, Slovenia and the Slovak Republic

Poland and Turkey, which are also seeking EU membership, are expected to complete their EEA membership formalities shortly.

Membership negotiations are also under way with Switzerland.

After each indicator a letter in brackets shows what issue in the DPSIR chain the indicator belongs to.

4.1.1 Agriculture

YIR01AG09 **Structure of Common Agricultural Policy support (R)**

This indicator shows the expenditures under the Common Agricultural Policy for animal and plant products and rural development as millions of Euros per year 1994-1999 and estimates for 2000 - 2006. These agri-environmental measures are part of support under 'Rural Development and Accompanying Measures'. They have been especially designated to deliver environmental benefits, though reduction in the use of fertilizers, specific application techniques, timing and agricultural activities etc. Most measures are site-specific.

The outcome of the indicator is that the relationships between the effects of subsidies on the structure of agriculture and the resulting impacts on the environment are complex. Several analyses of the effect of the CAP reform and the possible effect of the Agenda 2000 reform exist, but this information is difficult to present as indicators.

Comment: Money spent on national level on agri-environmental measures is hard to link to prevention of hazards or minimizing their effects on regional level.

YIR01AG11 **Area under agri-environmental management contracts (R)**

This indicator shows a EU-wide map presenting the area under agri-environmental management contracts in all member states.

In the Environmental Signals 2000 report the EEA states that "while all Member States made use of the opportunities under the agri-environmental Regulation 2078/92, the extent of uptake varies considerably from more than 60% of farms in Austria, Finland and Sweden to 7% or less in Belgium, Greece, Spain and Italy. However, area alone gives no indication of the environmental performance of the scheme as many of the programmes lack precision in the protective objectives and have no monitoring provisions."

Comment: The data is presented only in country level and the area under agri-environmental management contracts is hard to be directly linked to specific environmental trends.

YIR01AG08 **Intensification of agriculture (D)**

Three figures are shown: Index graph from 1975 to 1997 of permanent pasture, arable land, permanent crops and number of holdings; distribution of total cattle heads by number of heads per farm; and distribution of total pig by number of pigs per farm (EU12). One map: livestock units per hectare of utilized agricultural area in the EU in 1995 (NUTS 2 level?, Finland 5 units).

Intensification, greater specialization and unit-enlargement can have environmental consequences. For example, high-yield fodder crops reduce the amount of land needed for grazing animals, which can lead to loss of permanent pastures.

Data from Eurostat are from Farm Structure Survey (FSS) reported by Member States to Eurostat every 2-3 years (obligatory). However, many discrepancies were observed in Eurostat series, especially regarding obvious breaks in area statistical series for 1975-1987 and 1990-1997, and FAO series were used instead. In Eurostat statistics, many countries show unexplained sharp changes between 1987 and 1990.

Comment: intensification of agriculture could be interesting in regional level in the point of view of preventing hazards.

Intense agriculture (monocultures, use of heavy machines, eradication of hedges etc.) intensifies surface water runoff and increases the probability of flooding in consequence of heavy rainfalls.

Some forms of intense agriculture are highly vulnerable towards extreme weather events (especially greenhouses against hailstorms); in general, the more intense the agriculture is, the higher is the damage potential.

In this context the degree of nature-oriented farming within a region could be a good response indicator (prevention of flooding and landslides).

4.1.2 Air Quality

YIR99AP6 **Areas exposed to acidification and eutrophication (I)**

This indicator shows two time trends: ecosystem areas as percentage of country areas (EE18) damaged by acidification (sulphur and nitrogen) and eutrophication (5ht percentile). Policy issue: Exceedance of critical loads for the deposition of acidifying substances and ambient air concentration thresholds have been used in the negotiations of the emission reduction protocols for sulphur (1994) and the new multi-effect protocol on acidification, eutrophication and ground level ozone that was signed in autumn 1999. Exceedances of critical loads are also covered by the Acidification Strategy of the Commission.

The indicator is summarized on EE18 level and it is not applicable as a regional planning indicator in the present form. However, the original Critical Load data are published in EMEP150 (150 km x 150 km) and EMEP50 (50 km x 50 km) grid by the Coordination Centre for Effects, Working Group on Effects of the Convention on Long-Range Transboundary Air Pollution. Areas in which the deposition of acidifying components exceeds the critical limit may be more vulnerable to certain natural or technological hazards, for example the buffering and filtering capacity of the soil can be reduced because of the prolonged acid deposition. However, the critical load exceedance in different kinds of ecosystems cannot be directly linked to soil properties.

Comment: There are likely to be interrelations between acidification and eutrophication and the one or other hazard. This should be clarified in one of the next steps. Maybe this data might also be used as an indicator for the intensity of agriculture.

4.1.3 Climate Change

YIR99CC6 **Global and European average temperature (S)**

Global and European annual mean temperature deviations 1856-1999. No regional component. No estimates for further development. Not applicable for ESPON Hazards.

Other climate change indicators mentioned in terms of reference:

Carbon dioxide emissions

Emissions of greenhouse gas

Fluorinated gas emissions

Methane emissions

Nitrous oxide emissions

Comment: The EEA emission and average temperature indicators are not applicable in NUTS3 regional level. However, climate change models will be taken into account in future steps of the ESPON project, see Chaper 3.4. on Analysis of climate change studies applicable on European and regional level.

4.1.4 Coastal Seas

YIR01HS01 **Input of hazardous substances (cadmium, mercury, lead, zinc, lindane and PCB_7) into the North East Atlantic (including the North Sea), 1990 to 1998 (S)**

This indicator shows direct and riverine input loads of hazardous substances into the North East Atlantic as an index summary value per year and country contributions to sum of direct and rivering inputs in tones a year. Only available from OSPAR and HELCOM area, no data from Mediterranean.

Comment: This indicator may be applicable on certain coastal regions.

4.1.5 Energy

Oil spills

YIR01EN10b **Accidental tanker oil spills to the marine environment (P)**

This indicator provides a partial indication of the total amount of oil released to the marine environment from the transport of oil. It is based on reported oil spills of greater than seven tonnes from tankers, combined carriers and barges in the North East Atlantic, Baltic and Mediterranean Sea.

The impacts of accidental spills can be catastrophic on coastal zones. They can also have harmful consequences for tourism, mariculture and fisheries in affected areas. However, there are many factors that affect the usefulness and reliability of indicator. The mass of oil spill is approximate. The total amount released is likely to be more than the figures indicated because of spills and discharges of less than seven tonnes and unreported and undetected spills. Major oil spills still occur at irregular intervals. Oil enters the marine environment from a number of sources. Offshore activities, refineries and discharges from land-based activities are also significant source of oil pollution but no reliable data sources exist at present. This specific indicator of accidental tanker oil spills might also be difficult to contribute by spatial planning. Controls on the release of oil from shipping are set by the International Convention for the Prevention of Pollution from Ships (MARPOL Convention).

Meta data: The geographical scope of data is worldwide. Database is provided by ITOPF (International Oil Tanker Owners Federation). Still the present fact sheet is restricted to the EU-15. Temporal coverage is from 1974, future prognosis do not exist. List of major accidental oil tanker spills (>20000 tonnes since 1978).

Comment: Accidental oil spills occur at irregular intervals, future prognosis are difficult (or impossible) to make. Still, it is a very promising indicator that covers only EU-15 countries.

Nuclear waste production (P)

This indicator provides data on the quantities of spent nuclear fuel produced (generated). This is governed mainly by the quantity of electricity generated from nuclear plant, hence the projected decrease in quantities of spent fuel produced after 2000. Ideally a radioactive waste indicator would show the quantities of all the different types of waste produced. Spent fuel generated is a radioactive waste indicator for the energy sector. This data provides some indication of the radioactive waste situation and its evolution over time. Annual generation of spent fuel is expected to decrease. However, the stock of spent fuel and other nuclear waste waiting final disposal continues to increase.

The potential impact of spent nuclear fuel on humans and the environment depends on the level of radioactivity and the way in which the material is managed.

The European Atomic Energy Community (the EURATOM Treaty) gives regulatory functions regarding issues related to radiological protection, supply of nuclear fissile materials and nuclear safeguards. However, they don't quite so much deal with operational safety of nuclear power plants and radioactive waste storage or disposal facilities. These aspects have become the responsibility of the National Authorities. There is convention by the International Atomic Energy Authority (IAEA) that is signed by all EU member states and Norway. This convention sets out the measures to ensure the safe management of radioactive waste and contains requirements.

Meta data: Data source is provided by OECD. The geographical scope of data is EU-15 and Iceland, Liechtenstein and Norway. The temporal coverage of data is 1985-1998, the future fuel projections are made for 1999-2010.

Comment: This is a useful indicator for ESPON Hazards. Concerning nuclear waste, two aspects are of high relevance: The amount of the production of nuclear waste is an indicator for the intensity of nuclear energy production. But not only the amount of nuclear waste, also the specific conditions on and around the site of a nuclear power plant are of high relevance for the spatial risk. Besides the production of nuclear waste also the transport and storage of nuclear waste produce certain risks that might be monitored if data is accessible.

4.1.6 Households

YIR01HH03 **Household number and size (P)**

Indicates the number of persons per household. The increase in number of households causes increase in transport and changes in land use as more dwellings are needed.

Meta data: Persons per household = population / number of households. Temporal coverage 1980-1995, population data until 1999. Eurostat has collected data on household numbers in 1991. Data used is based on marketing data and statistics (Euromonitor). Geographical coverage is EEA countries. Data is on country level, NUTS 0 or NUTS 1.

Comment: The applicability of this indicator for Hazards-project is not clear, but maybe it can be appropriate for ceratin hazards, especially concerning risk evaluation.

4.1.7 Soil

Percentage contribution to soil contamination from localised sources

YIR01SO01 **Soil polluting activities from localised sources (P)**

This indicator provides the percentage contributions to soil contamination from localised sources. Accidents, which can be interpreted as a hazard, are presented.

Meta data: National data have been obtained from EEA-ETC/S. There are test areas from selected European countries and regions. The data shows the current status.

Comment: There is no quantitative information yet available about the scale and seriousness of contamination in the EEA member countries of the types of pollution. A direct quantification of hazardous substances input into soils is almost impossible. Data on soil polluting activities is useful for the project.

Progress in the management of contaminated sites

YIR01SO03 **Progress in the management of contaminated sites (R)**

This indicator is a measure of the progress of remediation of inventoried contaminated sites in relation to the estimated total requirements.

Emissions from contaminated sites can affect the quality of soil and water, particularly groundwater. The term ‘contaminated site’ implies historic or continuing contamination and the management of contaminated sites involves mainly such contamination. The data only cover progress in management of contaminated sites at a certain times, so no trends can be derived.

Meta data: National data have been obtained from EEA-ETC/S. There are test areas in 10 countries and national data is available from 9 EEA countries. The data shows the status in 1999.

Comment: Data provide the management of contaminated sites. It helps to priories remediation on most significant sites. A useful indicator for estimating the number of contaminated sites and the situation considering the phase of remediation process.

4.1.8 Tourism

Tourism intensity

YIR01TO10 **Tourism intensity (beds per capita) (D)**

This indicator shows the number of beds available per international tourist. However, 80 to 90% of tourism trips are within the country and most of the pressure on accommodation, infrastructure, resources and the environment comes from national tourism.

Meta data: National data is available from Austria, Spain and France. Eurostat database is available for EU-15 countries.

YIR01TO08 **Tourism arrivals (D)**

This indicator shows the total international inbound tourism. Data on arrivals indicate tourism hotspots and pressures on the environment.

Meta data: The geographical coverage of the data is EU-15 and EFTA4. The annual data is processed by the World Tourism Organization (WTO) that also has a forecast for the future.

Comments: High tourism intensity may increase pollution. Tourism intensity is a problem with complex interactions between causes and effects. It may become critical in some sensitive areas. Tourism intensity doesn’t indicate the hazard itself but it can be used to map sensitive areas because of tourism or for tourism.

The intensity of tourism is a very important Driving Force indicator, especially in the Alpine regions. The intensification of tourism produces higher risks in two ways:

First, – for example – the degradation of forests or other close to nature ecosystems due to the construction of touristic infrastructure (ski lifts, ski slopes, roads etc.) or the disturbance of instable ecosystems due to massive touristic use (hiking, mountain biking) increases the possibility for flooding, landslides or avalanches.

Second, the increase of touristic facilities also increases the damage potential, especially as many touristic areas are situated in regions that are highly exposed to hazards (mountain regions, coastal regions). The concentration of touristic facilities and the quantity of lodging is used as indicator for the damage potential in a lot of projects inside the EU´s Integrated Coastal Zone Management strategy. See for example the "Micro scale risk evaluation study for selected coastal lowlands along the German North Sea and Baltic Sea coasts", written by Prof. Horst Sterr et. Al.

4.1.9 Transport

Land take TERM 2002 08 EU+AC (D)

Land is under continuous pressure from new transport infrastructure and roads are the biggest land consumer. It can be estimated that between 1990 and 1999 almost 10 hectares each day were consumed by new motorway construction in the EU and about 2 hectares each day in the ADs. The common transport policy (CTP) advocates an optimal use of existing infrastructure before creating new ones, partly to minimize land taken for transport infrastructure (European Commission, 2001). Some Member States have developed land-use policies and plans that restrict additional transport development in certain areas.

Data sources: CORINE land Cover data: CORINE land cover database version 6/2000 –250m grid resolution by ETC/LC.

Infrastructure data: Eurostat & National infrastructure statistics for ACs 1990-1998.

Comment: Applicable. This indicator can be connected to soil sealing.

EN14: **Accidental oil tanker spills**

See "ENERGY"

(No ID) **Implementation of strategic environmental assessment (SEA) in the transport sector (R)**

Legal context of the SEA Directive is described on the EU web pages as follows (http://europa.eu.int/comm/environment/eia/sea-legalcontext.htm):

The purpose of the SEA-Directive is to ensure that environmental consequences of certain plans and programmes are identified and assessed during their preparation and before their adoption. The public and environmental authorities can give their opinion and all results are integrated and taken into account in the course of the planning procedure. After the adoption of the plan or programme the public is informed about the decision and the way in which it was made. In the case of likely transboundary significant effects the affected Member State and its public are informed and have the possibility to make comments which are also integrated into the national decision making process.

SEA will contribute to more transparent planning by involving the public and by integrating environmental considerations. This will help to achieve the goal of sustainable development.

Some background information about the formal steps so far:

The Commission adopted in 1996 a Proposal for a Directive on Environmental Assessment of certain plans and programmes. This Proposal was amended by the Commission in 1999 after the European Parliament had its First Reading. This amended text formed the basis for negotiations at Council level with the 15 Member States in the course of 1999. In December 1999 the Environment Ministers reached a political agreement on a common text for the future Directive (the common position). The common position was formally adopted on 30/03/2000.

The European Parliament as co-legislator approved on 6 September 2000 the Common Position subject to the amendments voted at its plenary session (Second Reading). The Commission formulated on 16 October 2000 its opinion on the amendments to the Common Position voted by the European Parliament.

Comment: This indicator shows how the SEA directive has been adopted to the national or regional legislation in EU countries. There is a comprehensive list of the national situation in all Member States and a list of example of practical SEA applications.

Fragmentation of land and forests TERM 2002 06 EU+AC (S)

Fragmentation of land due to the expansion of transport infrastructure networks and the continuous growth in traffic in the ACs and the EU pose an important threat to biodiversity by direct disturbance and by fragmenting and isolating habitats. The average size of non-fragmented land is in the ACs 174 km^2 and in the EU 121 km^2. The fragmentation by land use is indicated to be the major threat to habitats and species populations e.g. by The UN Convention on Biological Diversity and European Community Biodiversity Strategy. Most countries have guidelines for road and rail construction that involve some measures for providing passages for animals.

Data sources: CORINE land Cover data: CLC database version 6/2000 re-sampled to 1 km2 grid cells produced by ETC/LC.

Infrastructure data: Eurostat GISCO Reference database.

This indicator can be used for forest fire indicators.

Comment: Applicable, can be used for forest fire indicators. The more the ecosystems of an area are near-natural, the higher is the damage potential of the ecosphere of that area. If this could be expressed in a monetary way, it should be used for ESPON Hazards.

Freight transport demand by mode TERM 2002 13 EU (D)

Freight transport demand (in terms of tonne-km) grew faster than GDP (gross domestic product), thereby moving away from the objective of reducing the link between economic growth and freight transport demand. Road haulage and short sea shipping remain the main freight transport modes, with a share of respectively 43 and 42 % of the tonne kilometers. The EU has set itself following objectives to achieve sustainable transport:

reduce the link between economic growth and freight transport demand (decoupling); Shift in transport use from road to rail and water transport (SDS); Bring back the shares of alternative modes (rail, inland waterways, short-sea shipping and pipelines

Description of data: Data contains the measure of goods transport (tonne-km) by road, rail, inland waterways, short sea shipping and oil pipelines.

Comment: Not applicable. Especially if not in NUTS 3 level because it does not categorize the freight, e.g. hazardous substances.

Illegal discharges of oil at sea TERM 2002 10a EU+AC (P)

Shipping and oil transportation are an important source of pollution is sea areas, either during operations or from accidents. Specific aerial surveillance of illegal oil spills is conducted over the Baltic Sea and North Sea. These oil spills has been decreased slowly in the North Sea but remained constant in the Baltic Sea. No surveillance is conducted over the Mediterranean and Black Sea. Data source: Helsinki Commission, Bonn Agreement

Comment: Not applicable. The number of oil spills is not very exact indicator. And not related to any hazard.

Transport accident fatalities TERM 2002 09 EU (I)

Even though road fatalities per year have fallen by 15% since 1990, they still numbered more than 41 thousand in 1999. This reduction is attributed to improve road design, changes in legislation on drinking and driving, higher vehicle safety standards, introduction of speed limits, stricter rules on truck and driving times and reduced truckload capacities. Road is the least safe transport mode and aviation is the safest transport mode, followed by rail.

Data source: Road fatalities and fatality rates from Eurostat Statistical Compendium (Eurostat, 2002). Rail fatalities from Eurostat Statistical Compendium (Eurostat, 2002)

Comment: Not applicable for Espon_hazards project

Transport accident fatalities TERM 2002 09 AC (I)

The annual number of people killed in road accidents degreased significantly, by 18% in the AC13 between 1990 and 1999, despite growing road transport volumes. However, road accidents still claim around 21 thousand lives a year.

Data source: **UNECE, 2001**: road fatalities, accidents and injuries and number of passenger cars, buses/coaches and trucks. **ECMT, 2000**: road fatalities, accidents and injuries and passenger-km by car used for gap filling data for some countries

Comment: Not applicable for Espon_hazards project

Waste from road vehicles (end-of-life vehicles) TERM 2002 11a EU (P)

A substantial increase in the amount scrapped end-of-life vehicles in the EU+3 countries is foreseen, due to constant replacement of passenger cars. The number of scrapped cars is estimated to increase by 27% between 2000 and 2015. In the EU directive of end-of-vehicles (Directive 2000/53/EC) this is emphasized through the targets set up on treatment scrapped cars. Before 2006 80% of the waste from car scrapping should be reused or recycled.

Data source: EEA-ETC/WMF, 2000; EEA-ETC/WMF, 2001 for number of scrapped cars. United Population Statistics, 2001 for estimation of population in EU 15+3 in 2005, 2010 and 2015.

Comment: Not applicable for Espon_hazards project

Waste from road transport (end-of-life vehicles) TERM 2002 11a AC (P)

The number of scrapped cars is estimated to increase by 124% between 2000 and 2015. As a consequence here of Accession Countries will need to focus on improvement in the dismantling and shredder industry.

Data source: EEA-ETC/WMF, 2001 for number of scrapped cars.

Comment: Not applicable for Espon_hazards project

4.1.10 Waste

(No ID) **Total waste generation (P)**

Quantity of waste is an indicator of the material efficiency of society. The data on total waste generation by sector is also available. However, the hazardous contents of waste are poorly described at the EU level.

The limited information available indicates that total waste generation in the EU is increasing. Managing waste causes a number of pressures on the environment.

Meta data: The geographical scope of data is EU and Norway and Iceland. The main data source is Eurostat, still data is in some cases based on rough estimates.

Comment: A useful indicator but poor data reliability.

(No ID) **Generation and treatment of sewage sludge (R)**

Sewage sludge can be a valuable fertilizer but it is often contaminated with heavy metals, micro-organisms and hazardous organic substances. This indicator provides both the amount of sludge and treatment of sewage sludge. There is also some information on the contamination of sludge.

Meta data: The data is available from EU-15, except Italy. Still a better geographical coverage in data is needed especially for the content of sewage sludge. There are forecast for 2000 and 2005 of the amount of sludge from wastewater treatment.

Comment: The possible risk for environment of using sewage sludge depends on the contamination levels of sewage sludge.

4.2 General Comment on Indicators

Regarding the existing indicators in combination with our proposed conceptual framework and the variety of natural and technological hazards it might be important to construct a network of interrelations for every hazard that shows the driving forces, pressures, impacts and responses. This would be the foundation for the attribution of indicators. We elaborate on this idea in chapter 6 .

4.3 Analysis of the EuroStat, Joint Research Centre and EuroGeoSurvey indicators

4.3.1 Analysis of the Eurostat's Regio data

Eurostat's mission is to provide the European Union with a high-quality statistical information service. Eurostat is the Statistical Office of the European Communities situated in Luxembourg. Its task is to provide the European Union with statistics at European level that enable comparisons between countries and regions. For more information, please visit http://europa.eu.int/comm/eurostat/.

REGIO is Eurostat's harmonised regional statistical database. It covers the main aspects of economic and social life in the European Union, classified to the first three levels of the Nomenclature of Statistical Territorial Units (NUTS). The REGIO statistical data can be linked with this geographical information via the NUTS code.

Contents of REGIO database

- Agriculture
- Demographic statistics
- Economic accounts
- Education statistics
- Community labour force survey
- Migration statistics
- Science and Technology (research and development, patents)
- Structural business statistics
- Health statistics
- Tourism statistics
- Transport and energy statistics
- Unemployment
- Regions: Statistical yearbook 2002

The Eurostat data will be used to develop the indicators relavant for this project. Please find table 1 below with the Eurostat data the project 1.3.1 has access to. A list of requested data can be found in chapter 5.3.

Table 1: Eurostat REGIO Indicators available to project 1.3.1

DATA THEME DATA LAYER	DESCRIPTION OF CONTENTS	RESOLUTION/ SCALE	SPATIAL EXTENT	VOLUME (Mb)	COPYRIGHT AND SOURCES	REFERENCE CODE
NUTS version 6 (1995-), 3 million	Boundaries of 1 031 NUTS regions 4 hierarchical levels	1/3 000 000	EU15	7.1	CEC-Eurostat/GISCO and DG XI Administrative map of the EC (1:3 Mio)	NUEC3MV6
NUTS version 6 (1995-1998), 1 million	Boundaries of 1 031 NUTS regions 4 hierarchical levels	1/1 000 000	EU15	7.5	CEC - Eurostat/GISCO: derived from Commune Data Base	NUEC1MV6
NUTS version 7 (1998-), 20 million	Boundaries of 1402 NUTS regions 4 hierarchical levels	1/20 000 000	EU15+4 EFTA countries+10 Central European Countries	5.64	CEC - Eurostat/GISCO: derived from Commune Data Base	NUEC20MV7
NUTS version 7 (1998-), 10 million	Boundaries of 1402 NUTS regions 4 hierarchical levels	1/10 000 000	EU15+4 EFTA countries+10 Central European Countries	6.7	CEC - Eurostat/GISCO: derived from Commune Data Base	NUEC10MV7
NUTS version 7 (1998-), 3 million	Boundaries of 1402 NUTS regions 4 hierarchical levels	1/3 000 000	EU15+4 EFTA countries+10 Central European Countries	10.9	CEC - Eurostat/GISCO: derived from Commune Data Base	NUEC3MV7
NUTS version 7 (1998-), 1 million	Boundaries of 1402 NUTS regions 4 hierarchical levels	1/1 000 000	EU15+4 EFTA countries+10 Central European Countries	15.5	CEC - Eurostat/GISCO: derived from Commune Data Base	NUEC1MV7
Administrative regions version 7, 1 million	3 hierarchical levels	1/1 000 000	9 Central European Countries	8.3	CEC - Eurostat/GISCO derived from NUTS 1 million version 7, updated with boundaries from SABE 1995 and codes from Eurostat in 1999	ARNE1MV7
Airports Pan Europe	Location of 1 612 airports Attributes: name, different codes, type, altitude	Location of airports	Pan Europe	2	CEC - Eurostat/GISCO: modified from various sources	APEU
Airports eligible to Trans European Networks program, version 4	Location of 331 airports, 9 airport systems Attributes: name, different codes, type	Location of airports	EU15	0.1	CEC - Eurostat/GISCO	APEUTNSYV 4
Ports Pan Europe	Location of 1 848 ports	Location of ports	Pan Europe	0.2	CEC - Eurostat/GISCO	POEU

	Attributes: name, different codes					
Ports eligible to Trans European Networks Program version 2 (sub set of the port coverage with attributes)	Location of 619 ports	Location of ports	EU15	-	CEC - Eurostat/GISCO	POEUTNV2
Road network Pan Europe version 4, 1 million	Major Road Network + Access points	1/1 000 000	Pan Europe	15.3	IRPUD	RDEU1MV4
Road Network eligible to Trans European Networks Program, version 4 (subset of road coverage with attributes)	TEN road network	1/1 000 000	EU15	-	CEC - Eurostat/GISCO	RDEU1MV4. RATRDPLTNSC
Railway network Pan Europe version 4, 1 million	Major Railway Network + Access points	1/1 000 000	Pan Europe	15.3	IRPUD	RWEU1MV4
Railway Network eligible to Trans European Networks Program, version 4 (a sub set of the major railway network)	TEN railway network	1/1 000 000	EU15	-	CEC - Eurostat/GISCO	RWEU1MV4. RATRWPLTNSC
Urban centers Pan Europe	Location of 7 269 urban centers (> 20 000 inhabitants, for some > 10 000) Attributes: name, area, population number	Location of urban centers	Pan Europe	0.6	CEC - Eurostat/GISCO: modified from W.H.O. with different sources	STEU
Urban centers being national/regional capital, EU15 + EFTA	1227 urban centers	Location of urban centers	EU15 + EFTA (UK only partially available)	0.12	CEC - Eurostat/GISCO	STEUCPV7.INF
Urban centers being national/regional capital for the PECO cuntries	165 urban centers	Location of urban centers	BG, CZ, SI, SK, EE, PL, HU, LT, LV, RO	0.1	CEC - Eurostat/GISCO	STARCPV7.INF
Water pattern Pan Europe version 2, 10 million	Most important rivers and lakes 1 100 river segments and 330 lakes	1/10 000 000	Pan Europe	1.5	CEC - Eurostat/GISCO	WPEU10MV2
Watershed boundaries Pan Europe, 10 million	190 drainage basins defined	1/10 000 000	Pan Europe	1	CEC - Eurostat/GISCO	WSEU10M

Watershed boundaries Pan Europe, 3 million	240 drainage basins defined	1/3 000 000	Pan Europe	2	CEC - Eurostat/GISCO: modified from various sources	WSEU3M
Catchments, Pan Europe, 1 million		1/1 000 000	Pan Europe	20		WSEU1M
Digital Terrain Model Pan Europe, 20 million	Digital Elevation (altitude in meters) Grid for Pan Europe 5 minutes longitude/latitude resolution	1/20 000 000	Pan Europe	1.7	US NGDC: Etopo-5	DEEU20M
Fishing areas Pan Europe, 3 million	Subdivision of Marine area's for statistical purposes	1/3 000 000	Pan Europe	1.2	CEC - Eurostat/GISCO	FAEU3M
Fishing areas Pan Europe, 10 million	Subdivision of Marine area's for statistical purposes	1/10 000 000	Pan Europe	0.4	CEC - Eurostat/GISCO	FAEU10M
Landscape types Pan Europe	Landscape type of Europe 30 landscape types in 8 landscape complexes	1/6 000 000	Pan Europe	0.2	CEC - Eurostat/GISCO - DGXI - TF-EAA	LSEU
Inventory of the natural vegetation according to phytosociological associations	4 160 polygons 232 vegetation types	1/3 000 000	Pan Europe (except East European countries)	5.8	CEC - Council of Europe - Eurostat/GISCO	VGEU
Digital Terrain Model World	Grid coverage in geographical coordinates 5 minutes latitude/longitude resolution	1/20 000 000	World	16	US NGDC: Etopo-5	ALWDGG
Fishing areas World, 25 million	Subdivision of Marine area's for statistical purposes	1/25 000 000	World	10.236	CEC - Eurostat/GISCO	FAWD25MG G

4.3.2 Analysis of Joint Research Centre indicators

The Institute for Environment and Sustainability (**IES**) is one of the institutes that constitute the Joint Research Centre (**JRC**) of the European Commission. In line with the JRC mission, the aim of IES is to provide scientific and technical support to European Union strategies for the protection of the environment contributing to a sustainable development. IES works in close collaboration with official laboratories, research centres and industries of the EU's Member States, creating a bridge between the EU's policies and the European citizen. A special consideration is given to the EU enlargement process by expanding all IES existing networks to the applicant countries. The combination of complementary expertise in the fields of experimental sciences, modeling, geomatics and remote sensing puts the IES in a strong position to contribute to the implementation of the European Research Area and to the achievement of a sustainable environment.

Natural Hazards Project **FP5-Project n°36 *Environment* NATURAL HAZARDS *Institute for Environment and Sustainability***

The Natural Hazards project is targeted to provide scientific and technical support (risk indicators and damage maps) for the conception of implementation and monitoring of EU policies linked to the protection of the environment and of the citizens against floods and forest fires. Furthermore the envisaged activities will provide tools for the improvement of existing practices in disaster management during the prevention - and preparedness phase (Risk indicators development, Flood forecasting system) and after the crisis-phase (damage assessment). This will be achieved by the integration of information derived from Earth observation data and from other data sources.

Forest Fires

Forest fires are seen as recurrent phenomenon. Fires used to be natural phenomenon but nowadays the fires are more or less anthropogenic due to i.e. increasing population growth and density. There is a lack of harmonized information on fire occurrence and fire damage at the European scale but activities on forest fires are aimed at obtaining harmonized products for all the European countries.

Indicators of forest fire risk are developed at the local level, or sometimes at the national level. However, forest fire risk is not a local phenomenon. Variables at the regional level have a direct influence on forest fire risk. On the line of this scope, the Natural Hazards project was established to work on the development of fire risk indices and regional variables at the European level.

The products of the ongoing project will be:

Fire Risk Assessment

- *Structural Risk Index*
- *Dynamic Risk Index 1*
- *Dynamic Risk Index 2*
- *Fire Potential Index*

Fire Damage Assessment

- *Algorithm Development and Validation*
- *Damage Assessment*

Burnt Area Watch

Meteo Applications

- *Fire Risk Watching*

European **F**orest **F**ire **R**isk **F**orecasting **S**ystem (EFFRFS)

- Forest fire risk maps for the whole EU
- Resolution 4*4 km
- Canadian Fire Potential Index (FPI) -> weekly average of fire risks
- Inputs in the FPI model
    - Fuel map; dead and live fuel loads
    - Satellite data; vegetation indices
    - Meteorological data; dead vegetation moisture content
- Coming improvements
    - Land-cover information
    - Calibration of FPI risk intervals
    - Development of historical fire risk trend indicators

European **F**orest **F**ire **D**amage **A**ssessment **S**ystem (EFFDAS)

- Mapping of fires larger than 50 ha

European **F**orest **F**ire **I**nformation **S**ystem (EFFIS)

- Test version is available at http://natural-hazards.jrc.it/fires/risk/products/dynamic/euffis-test.html

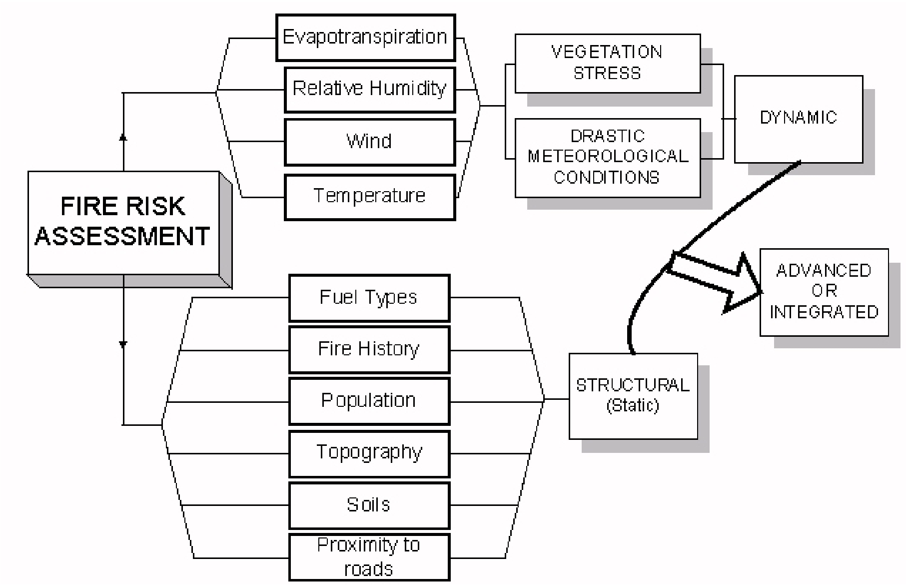


Figure 4. A flowchart showing some of the variables used to compute the three types of indices in forest fire risk evaluation. (Source http://natural-hazards.jrc.it/fires/risk/overview/) At this moment the only product available is vegetation stress index.

Floods

In the last decade Europe has experienced a number of unusually long-lasting rainfall events that produced severe floods. According to the WMO statement on the status of the global climate in 2001 the trend seems to be continuing. The problems of floods are addressed on different temporal and spatial scales, ranging from the assessment of the economic loss in a village through flooding to the simulation of the flood risk over the last 40 years. The summary of events seems to support projections of future climate indicating that further increase in severe floods in North and Northwest Europe are likely.

The development of modeling tools to aid in assessing influence landscape factors, such as land-use changes, can have on the flooding problem is one of the flood activities carried out by IES. The physically based LISFLOOD model is being developed to simulate floods in large European drainage basins.

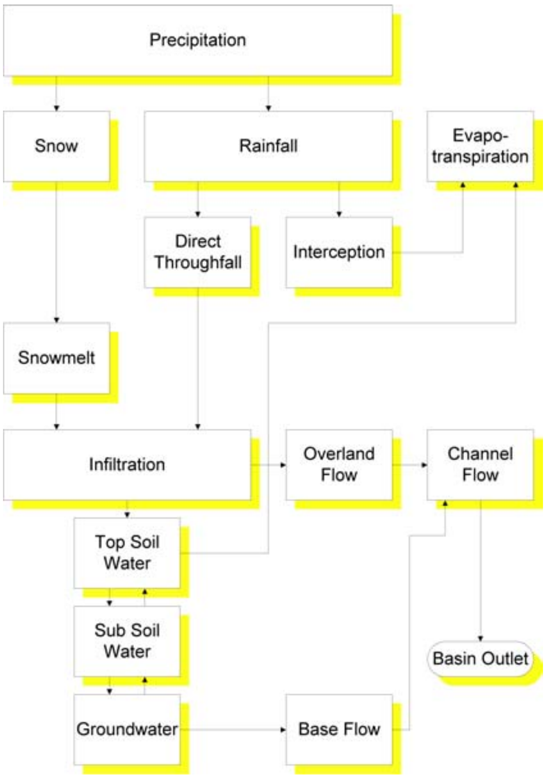


Figure 5. Flowchart of the LISFLOOD model.
(Source http://natural-hazards.jrc.it/floods/risks/)

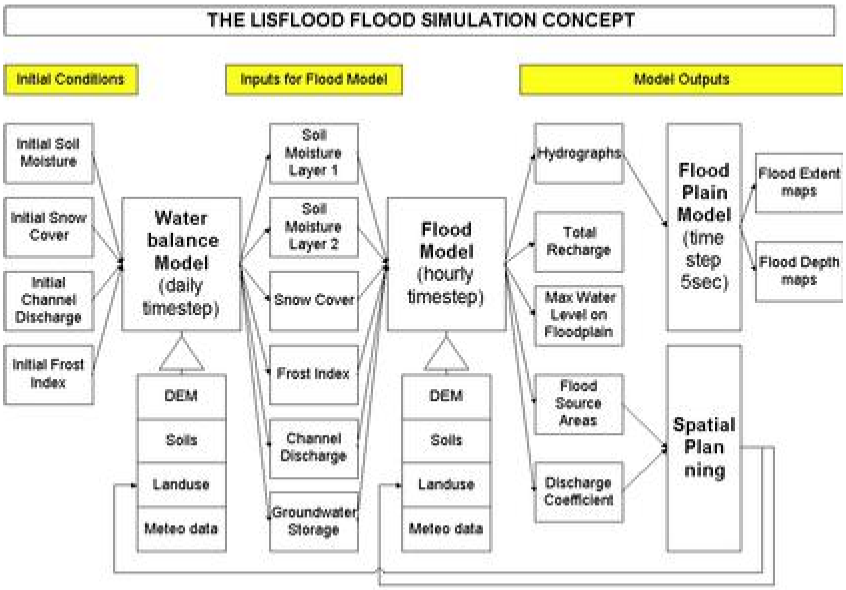


Figure 6. Diagram showing the three models of LISFLOOD model. (Source: http://natural-hazards.jrc.it/floods/risks/

The activities of the project will include

- Flood simulation and flood forecasting
- Scenario studies
- Impact of historic land-use changes
- Flood risk assessment

Flood Model Development and Validation

Model Comparision

Scenario Development

- Flood damage assessment.

Damage Extent Mapping

Damage Assessment

- Floodwatch
- Meteo Applications

Flood Forecasting

Maps and indicators

The ongoing Natural Hazards Project could provide ESPON_Hazards –project with some indicators but in the near future there will be more specific and updated forest fire and floods related risk assessment maps coming out from the project. The geographical scope will be at European level covering also the accession countries. At this moment there already exists forest fire risk maps at the http://natural-hazards.jrc.it/documents/fires/risk-maps/. The initial focus of the forest fire activities is southern Europe, since this is the area most affected by fires in the European Union and the geographical scope of these fire risk maps does not include Northern Europe. At the site http://natural-hazards.jrc.it/documents/fires/general-interest/ there exist more coarse resolution forest fire risk maps covering the whole Europe. LISFLOOD is set up to simulate rainfall-runoff for the whole Europe on a 5 km grid. However, there are unsolved problems with high-resolution data availability on European scale. There are some examples at the sites http://natural-hazards.jrc.it/documents/floods/Animations/Rnf_MeuseFlood95.avi (European scale) and http://natural-hazards.jrc.it/documents/floods/Animations/Discharge_MeuseFlood95.avi (Central Europe).

References:

http://ies.jrc.cec.eu.int/

http://ies.jrc.cec.eu.int/Projects/HAZARDS/

http://natural-hazards.jrc.it/

http://natural-hazards.jrc.it/fires/

http://natural-hazards.jrc.it/floods/

4.3.3 Analysis of Eurogeosurveys and Geoindicators

Geoindicators are measures of geological processes and phenomena occurring at or near the Earth's surface. They measure both catastrophic events and those that are more gradual, but evident within 100 years or less. An international project by the Commission on Geological Sciences for Environmental Planning of the International Union of Geological Sciences (IUGS) has developed a geoindicator checklist (Berger and Iams 1996).

Although geoindicators describe processes that go on without human interface, human activities can accelerate, slow or divert natural changes. Geoindicators are concerned more with the build-up of a natural hazardous event such as earthquake or volcanic eruption, rather than the event itself. For example, a single earthquake is not a geoindicator, but the seismicity geoindicator reflects the state of stress and its release within specific regions, which may lead to an earthquake.

The IUGS Geoindicator checklist includes several indicators that can be connected to some of the most serious hazards in regional scale. However, the indicators are described in very general level and they are not applied in European or regional scale. The indicator checklist is a tool that can be used to define indicators in regional scale. For the ESPON Hazards project, the most promising geoindicator descriptions are the following:

One of the suggested indicators is called 'Seismicity related to shallow-focus earthquakes'. Seismic observations are one of the oldest forms of systematic earth monitoring. Seismic networks provide information about the location, size and motion of earthquakes. Even though earthquakes are predominantly natural events, shallow-focus seismic tremors can be induces by human actions that change near-surface rock stresses or fluid pressures. These actions include extracting or pumping back for storage of water, gas, petroleum or waste fluids; mining and quarrying; and loading the surface with water reservoirs as well as major underground explosions. The standard seismograph observations networks are operating and needed. The effects of increases in crustal stress, which can be released through earthquakes, is becoming increasingly important as a tool for estimating seismic hazard. Changes in crustal stress may be indicated by certain geological and geophysical precursors, including fluctuations in water table levels in wells, changes in geomagnetic fields, piezoelectric effects, and ground surface tilting, shortening and displacement.

Land sliding is commonly regarded as one of the most predictable of geological hazards. This geoinicator is called the 'Slope failure (landslides)'. The most important parameters for monitoring mass movements are: 1. formation and widening of ground cracks; 2. the appearance of and increases in ground subsidence or upheaval; and 3. the area of slope failure is a measure of the extent of land sliding. Crack density is usually monitored in the highest part of the potential mass movement area. Upheaval or buckling generally begins in the toe area. Air photos are useful in determination of the extent of land sliding in large areas.

Another geoindicator called 'Surface displacement' describes small but important displacements such as uplift, subsidence, lateral movement, rotation, distortation and dilation that affect elevation and horizontal position. These movements result from tectonic processes, collapse into underground cavities or the compaction of surfical materials. For example, extraction of fluids beneath urban areas can induce land subsidence (Venice) and cause flooding. Subsidence can damage buildings. This indicator is important in active fault zones, coastal communities, deltas and urban areas extracting groundwater, oil and gas. Volcanic eruptions are almost always preceded and accompanied by volcanic unrest. 'Volcanic unrest' geoindicator is related to variation of geophysical and geochemical state of the volcanic system. Thus optimum monitoring system of volcanic unrest must be based on a combination of geophysical, geodetic and geochemical methods. These involve a network of monitoring sites at key locations around a volcanic center. Frequency of measurement s depend on activity of the volcano.

References:

Berger, A.R. & Iams, W.J. 1996. Geoindicators: Assessing Rapid Environmental changes in Earth Systems. Rotterdam: A.A.Balkema.

4.4 Selected regional indicators

In regard to Work Package 3 case study areas have to be selected to test the indicators in their applicability to spatial planning. In this applicability testing it is to consider that there is not only a single spatial planning system in the member states of the EU but a lot of different spatial planning systems. Because of this variation it is convenient to select case study areas which have different spatial planning conditions because only if the indicators are applicable to the different spatial planning systems and different prerequisites the efficiency/usage for the whole EU is to expect.

In addition to the received attention of the different spatial planning systems the variety of the natural and technical hazards in their different location is important. The case study areas should cover a wide variety of natural and technical hazards and therefore it is necessary to select case study areas that have to deal with different hazards like mountainous regions (avalanches, moraines) and industrialised regions (big damage potential and different risks like toxic water pollution). The regional indicators that are utilisable in the Work Package 3 depend on the selected case study areas and their hazards. Because of this the selection of regional indicators has to take the localisation of the case study areas and the available of data into their consideration.

Geographical level: The geographical level will be NUTS 2-level. The case study areas/regions are the NUTS 2-regions: DED 2, which is the administrative district of Dresden, Central Region of Portugal, Region of Itä-Uusimaa, Switzerland, Andalusia

Technology required for data collection: GIS application (ArcView) and corresponding data basis (E00 - Files or ArcView-shape files), scale of the data basis at least 1:100.000.

Risk plans do not exist in this regions generally but the vulnerability could be derived from indicators which show the sensitivity in regard to natural/technical hazards. Indicators with this meaning are:

Data (maps) of the density of population

Data (maps) of the GDP per person

Out of the comparison of the risk indicators (1) with the sensitive indicators (2) the vulnerability could be valuated.

Table 2: Selected natural/technical Hazards and available indicators in the in the case study areas:

Hazards	Indicators
Flooding	Flood area (S) Frequency of floods (P) Deforestation (P) Sealing (P) Historical discharged volumes in different sections of the rivers Changes in Spatial Planning (R) De-sealing (R)
Forest Fires	Historical maximum temperatures and lowest precipitation (P) De-forestation (S, I)
Seismicity&Earthquakes	Earthquakes in mining areas (P) Active faults (P) Instrumental and historic seismicity (P) Seismic zoning for constructions (R)
Stream sediments/Soils Contamination	Contaminated sediments/Soils (S) Uranium mining zones (distribution)(P) Chemical and Metallurgic Industry (sites of refineries, chemical industries, etc) (P)
Terrain Instability	Areas to mining subsidence (P)
Landslides	Occurred landslides (S) Changes in Spatial Planning (R)
Groundwater pollution	Groundwater quality (S) Aquifers vulnerability to contamination (S)
Traffic accidents	Aircraft approach lines near airports (limitation of settlement areas) (R) Transport of toxic chemicals in protected water gathering grounds (P)

4.4.1 Analysis of selected regional indicators

For the selection of the indicators a set of objective and feasible criteria was followed in order to reflect the meaning of the data in the original form. Some national and international institutions that publish data referring to the environmental indicators had been consulted, namely EEA, OECD, Eurostat, EPA, USGS and the national institutions in Portugal like IA (environmental administration), INE (statistical), IM (meteorological), among others and also the national institutions in Germany like SMUL (Saxony ministry for environment), LFUG (Saxony department for environment and geology), the mining office and regional planning departments in Saxony. The criteria used for the selection of the indicators described below were the existence of data (scale of the origin data base at least 1:100.000), its accessibility and reliability, the possibility of inter-calibration, the relevance of the indicator for the quantification of the risk and the easiness and rapidity of determination and interpretation of it. The hazards selected for this project also reflect the availability of these indicators. For each hazard, the indicators were integrated in the DPSIR model.

The geographical level for the analysis of the selected regional indicators will be the NUTS 2-level and the case study will be DED 2 (administrative district of Dresden), the Central Region in Portugal, the Regions of Itä Uusimaa in Finland and Andalusia in Spain as well as a region to be determined in Switzerland.

The hazards will be classified according to the characterisation explained in detail at the chapter 6 Further Investigation

As the risk/hazards Stream sediments and Soil contamination were classified as Pandora, may not be considered further approach on those risks/hazards.

4.4.2 Flooding

To study the flooding phenomenon several parameters have to be introduced, such as historical climate data, historical discharged volumes in different sections of the rivers, land use, urban areas, deforestation etc., which allow to evaluate the risk in certain periods of the year or in periods of several years. The indicators for each phase of the DPSIR chain could be: D – Climate change, Dam discharges, Urban zones; P- Deforestation, sealed areas; S- Soil erosion, Unprotected infra-structures, Physical chemical & biological degradation of the environment, Unsafe living conditions, Water contamination; I- Loss of lives; Damage to property; R- New policies & guidelines, Reconstruction, changes in land use & construction patterns.

Hazard/Risk Type	Flooding/Cyclops
Indicator	Deforestation
DPSIR model	Pressure indicator

Short description: Deforestation areas are particular vulnerable especially in hilly areas because the water flows without obstacles and with a minimum infiltration into the river channel.

Methodology: Integrated mapping overlaid with land use and industry data will be used to determine deforestation areas. Other methodologies will be tested.

Relations with other indicators: forest fires, groundwater pollution.

Origin of the data: National Water Institute, Coimbra University, Aveiro University, New Lisbon University, National Council of Environmental and Sustainable Development, Technical Engineering Institute of Lisbon
Saxony administration of storage reservoirs, Saxony department for environment and geology.

Hazard/ Risk Type	Flooding/Cyclops
Indicator	Sealing / conditioned land used areas
DPSIR model	Pressure indicator

Short description: Sealed areas are vulnerable especially in hilly areas because the water flows without obstacles and without infiltration into the river channel.

Methodology: Integrated mapping overlaid with land use and industry data will be used to determine sealed areas. Other methodologies will be tested.

Relations with other indicators: forest fires, groundwater pollution.

Origin of the data: National Water Institute, Coimbra University, Aveiro University, New Lisbon University, National Council of Environmental and Sustainable Development, Technical Engineering Institute of Lisbon.

Hazard/ Risk Type	Flooding/ Cyclops
Indicator	Historical discharged volumes in different sections of the rivers
DPSIR model	State indicator

Short description: Discharge data in different sections of the river channel and in a certain period of time related to high precipitation data and the time of arrival of a certain volume to a particular station will be an important tool to understand and predict the flooding phenomenon.

Case study area for flooding phenomenon

From the various hydrographical basins with available data, the Águeda River, an affluent of the Vouga River, was selected due to the characteristics that seemed to be particularly suitable for this project, such as: the dimension of the catchment basin, the forest area that surrounds it (allowing the study between the two phenomena – floods and forest fires), a reduced agricultural area, the city of Águeda, which suffers from constant flooding and the existence of control stations for measuring water level and rainfall. It is believed that the use of this basin as a case study, it will be easy to extend the outcomes of this research to the wider area of the Central Region of Portugal.

Methodology: Mathematical modelling has been tested by certain authors and their methodologies will be used in the test area.

The indicators are grouped in certain categories, namely, dimension, which are basically, different sides of the same phenomenon and the level in which the analysis is being undertaken. This will allow assessing the extent of:

- "Background forces" which support the flood phenomenon
- Pressure that areas at risk are suffering from
- State of those areas
- Impact of a potential flood phenomenon (by grouping the previous items: 1., 2.,3.)
- Capacity of response to this kind of hazard

Some of these indicators are more significant than others, therefore should be pondered according to their importance, so the level of risk for each of those groups of indicators can be measured.

Once the indicators are quantified and pondered accordingly, then, it will be possible to assess the level of risk for each of the five groups of indicators and faults detected, if that will be the case.

a. High (red) b. Medium risk (yellow) Response	Driving Forces/ Pressure/ State/ Impact/

After all these situations have been scored, then it will be possible to proceed with recommendations to spatial planning practitioners and policy makers, which are the ultimate goal of this project.

Some strategic documents, such as, the hydrographical basins plans, such as in Mondego River (Law- Decree nº9/2002), includes a list of indicators, and those only relate to the environmental, social, economic and financing impact of measures or actions, meant to graduate the impact of the plans as having a high positive impact level and/or a high negative impact level.

The National Water Plan (Decree-law nº112/2002 of 17 of April) foresees an evaluation according to a matrix of indicators that is similar to DPSIR methodology. However, these indicators are not yet available, since they are being created.

Origin of the data:

National Water Institute, Coimbra University, Aveiro University, New Lisbon University, National Council of Environmental and Sustainable Development, Technical Engineering Institute of Lisbon.

Institute of Ecological and Regional Development, Saxony administration of storage reservoirs.

Relations with other indicators: forest fires, groundwater pollution.

De-sealing rate could eventually be one of the response indicators. In long term spatial planning de-sealing can be applied in risk areas sealed with deactivated infrastructures. At the moment there are no available data concerning this indicator

4.4.3 Forest Fires

To study the forest fire phenomenon several parameters have to be introduced like maximum temperatures, lowest precipitation periods, land use, uncontrolled slash and burn fires, forest density, etc., which allow to evaluate the risk in certain areas and periods of the year. The indicators for each phase of the DPSIR chain could be: D – Maximum temperatures together with lowest precipitation periods, Forest density; P- Agriculture practices, Unclean forest areas; S- Soil erosion, Deforestation, Groundwater contamination; I- Loss of lives, Damage to property; R- New policies & guidelines, Reconstruction, Changes in land use & agriculture practices. The main emphasis of the hazard "forest fires" is in regard to the different main landscapes in Portugal.

Hazard/Risk Type	Forest fires/Cyclops
Indicator	Historical maximum temperatures and lowest precipitation along the year
DPSIR model	Pressure indicator

Short description: Historical information about maximum temperatures and lowest precipitation to predict periods of highest probability of the fire phenomenon related to areas of high forest density and dry vegetation are important to determine vulnerability areas to this hazard.

Methodology: Index determinations like "Index of forest fire danger" and "Nesteron Index" have been adapted to Portuguese cases. Institutions are gradually shifting to the Canadian Index FWI-Fire Weather Index, which applicability has been highly recommended to all European countries.

Relations with other indicators: flooding, groundwater pollution.

Origin of the data: National Centre of Emergencies and Civil Protection, National Services of Fire Brigades, Coimbra University, Aveiro University, National Council of Environmental and Sustainable Development.

Hazard/Risk Type	Forest fires/Cyclops
Indicator	Deforestation
DPSIR model	State indicator

Short description: Overlaying of historical forest cover mapping related to actualized land use data is important to determine vulnerability areas to this hazard.

Case study Area for Forest Fires Phenomenon

The Central Region of Portugal which covers an area of 23 700 km2, and where the drought phenomenon has been inflicted upon the inland area for some time now, making this aspect particularly serious since this region is predominately covered by forestry. More than 40% of total area is occupied by forestry, mainly the pine tree, eucalyptus, cork tree, which have been jeopardised by intense forest fires.

Methodology: Index determinations have been applied in some Portugal areas, such as "Index of forest fire danger" and "Nesteron Index". Institutions are gradually shifting to the Canadian Index FWI-Fire Weather Index, which applicability has been highly recommended to all European countries. It's possible that we will have to focus on a rather small but representative area of the Central region of Portugal.

Relations with other indicators: flooding, groundwater pollution.

Origin of the data: National Centre of Emergencies and Civil Protection, National Services of Fire Brigades, Coimbra University, Aveiro University, National Council of Environmental and Sustainable Development.

4.4.4 Seismicity / Earthquakes

According to the UNESCO definition in 1980, the seismic risk is related to the expected losses or damages for a certain element exposed to risk, during a certain length of time. The indicators for each phase of the DPSIR chain could be: D – displacement inter and intra tectonic plate; P – active faults, seismicity; S – ground movements, surface ruptures; I – damages on buildings, losses of lives; R – identification of the vulnerable zones of seismic action, spatial planning.

Hazard/Risk Type	Seismicity&earthquakes / Cyclops
Indicator	Active faults
DPSIR model	Pressure indicator

Short description: a fault is considered active if it suffered a displacement in the actual tectonic regime (usually considered by the national authors as the last 2 My) having, therefore, capability to suffer new displacements at the future. In a sense purely geologic, the activity of faults is measured by its slip-rate and is express in cm/yr. or mm/yr. However, the data available classifies active faults in function of geological and geophysical criteria. In contrast to Portugal there is no natural risk of earthquakes in Saxony. Earthquakes in Saxony have their origin in ancient mining zones and collapsing of old mine shafts. These earthquakes are restricted to mining zones and have just small locations but could have high intensity.

Methodology: There are various classifications for active faults especially in Portugal. We will collect the data from the different classifications and choose the most appropriate for our purpose.

Relations with other indicators: instrumental and historical seismicity, seismic zoning for constructions.

Origin of the data: J. Cabral (1995) – "Neotectónica em Portugal continental" PhD thesis, Universidade de Lisboa and other scientific papers
University of Freiberg, Saxony mining authority.

Hazard/Risk Type	Seismicity&earthquakes / Cyclops
Indicator	Instrumental and historic seismicity
DPSIR model	Pressure indicator

Short description: the seismicity detected for the seismographs and that which have historical descriptions of the damages give us information about the zones that are more vulnerable to the earthquakes.

Methodology: the seismic data are collected by the seismograph network and are published by the Instituto de Metereologia in monthly and annual bulletins. This institute has databases with the information about the historical seismicity.

Relations with other indicators: active faults distribution, seismic zoning for constructions.

Origin of the data: Instituto de Metereologia, Instituto de Geofísica da Universidade de Coimbra
University of Freiberg, Saxony mining authority.

Hazard/Risk Type	Seismicity/earthquakes / Cyclops
Indicator	Seismic zoning for constructions
DPSIR model	Response indicator

Short description: the seismic zoning for constructions was elaborated to quantify the action of the earthquakes on constructions. This action depends on the local seismicity and on the ground nature. The seismic zoning made for the Portuguese territory reflects the conjugation of the inter and intra tectonic plate seismicity. In Germany and the region of Saxony the seismic zoning reflects the risks of earthquakes out of break downs from ancient mines.

Methodology: the calculation of the action that an earthquake may cause on the constructions is made in terms of the seismic coefficient and then calculating the effect on the constructions through methods of dynamic analysis integrating the seismic data, the ground nature and the construction features.
In Saxony the possibilities to calculate the effects out of earth quakes are restricted because often there is no knowledge about the volume of (flooded) ancient mines. Out of this the seismic zoning contains in the most times restrictions of settlement areas.

Relations with other indicators: instrumental and historic seismicity, active faults, type of constructions, ground nature.

Origin of the data: Regulation for security and actions for buildings and bridges structures (Regulamento de segurança e acções para estruturas de edifícios e pontes, decreto-lei nº235/83 do D.R. nº125, Iª série)
Regional Planning authorities in Saxony

4.4.5 Landslides

This hazard could become problematic in case of high values of rainfall in areas with severe relief. In Portugal this hazard is still studied only at an academic level, not having a systematic gathering of data throughout the country. For this motive we present only the indicator of the landslides occurred recorded by the national service of emergency. The indicators for each phase of the DPSIR chain could be: D – inadequacy of the constructions, extreme climatic conditions; P – slope instability, water saturation of soils; S – occurrence of the landslide; I – damages on buildings, losses of lives; R – stability repairs, spatial planning.
It will be considered to look at Switzerland where landslides are a common hazard and the "Federal Office For Water And Geology" (FOWG) of Switzerland has a lot of results out of research.

Hazard/Risk Type	Landslides/Cyclops
Indicator	Occurred landslides
DPSIR model	State indicator

Short description: a landslide is a change of the ground morphology in consequence of the rupture and movement of large masses of rocks or land due to the gravity force.

Methodology: All the landslides occurred are communicated to the Serviço Nacional of Protecção Civil (national civil protection) that assembles all the data. We assume to make an inquiry to each municipality responsible in order to have a systematic gathering of data throughout the case study area and we will complete this with an inquiry about landslides in Switzerland (FOWG).

Relations with other indicators: quantity of water in soils, relief, occurrence of earthquakes.

Origin of the data: Serviço Nacional de Protecção Civil and inquires, Federal Office For Water And Geology.

4.4.6 Groundwater pollution

The indicators for each phase of the DPSIR chain could be:

D – Antropic activities: agriculture, cattle, industry and urban zones; P - Application of nitrogenous fertilizers, industrial, urban and cattle non-treated residues/effluents; S – Upper aquifers contamination by nitrates, heavy metals, organic matter and micro-organisms; I – Breaking the norms of water quality for public supplying has social, economic and sanitary implications, placing in risk the public health, beyond the sanctions foreseen by the European Union Water Framework Directive; R – To promote the quality of wells construction; to delimit the protection zones of wells; to implement a Code of Good Farming Practices, treatment of industrials, urban and cattle residues/effluents; application of aquifers remediation methods.

Hazard/Risk Type	Groundwater pollution/Cyclops
Indicator	Groundwater quality
DPSIR model	State indicator

Short description: Definition of water quality of aquifer systems through the quantification of water points (wells and springs) that do not fulfill the norms for human use established by the European Union legislation.

Methodology: The groundwater quality is defined comparing the result of the analyses of several parameters with the respective limit-values (*Maximum Values Recommended* and *Permissible Maximum Values*) established in the EU legislation. Water quality is evaluated, separately, in the several aquifer systems.

Units of measure: Number and/or percentage of samples, in each aquifer system considered, where the values measured are above the limit-values established by law.

Periodicity: Bi-annual (rain season and dry season).

Other indicators relationship: Aquifers vulnerability to contamination.

Data sources: Portuguese institutions – Instituto do Ambiente *(Environment Institute);* Instituto Nacional da Água *(National Institute of Water)*; Direcção Regional do Ambiente e do Ordenamento do Território do Centro *(Agency for the Environment and Territory Planning of Portugal Central Region)*; city councils; Universidade de Aveiro *(University of Aveiro)*; Instituto Geológico e Mineiro *(Geological Survey of Portugal).*
German institutions - Saxony ministry for environment, Saxony department for environment and geology

Hazard/Risk Type	Groundwater pollution/Cyclops
Indicator	Aquifers vulnerability to contamination
DPSIR model	State indicator

Short description: Variation of groundwater quality and evaluation in function of intrinsic characteristics of aquifers face to a specific pollutant load. According to FOSTER (1987), aquifers vulnerability to contamination can to be measured as the degree of inaccessibility of a pollutant to the aquifers saturated zone from the land surface, associated to the unsaturated zone capacity to attenuate the propagation through physical and chemical retention and/or reaction. The evaluation of aquifers vulnerability to contamination is a complex question, depending its validity on the degree of knowledge of the intervening variables.

Methodology: The evaluation of aquifers vulnerability to contamination will be made by a weighed matrix method, that must be defined consonant to amount and quality of information concerning parameters related with the intrinsic physical and hydrodynamic characteristics of aquifers, such as:

- Aquifer lithology;
- Depth of water table;
- Hydraulic Conductivity

- Impact of the unsaturated zone;
- Recharge;
- Soil type;
- Topography.

Nitrates will be considered as pollutant load. The vulnerability maps will be generated from raster analysis in GIS environment (ArcGis 8.2 - ESRI).

Units of measure: The vulnerability of each aquifer will have to be defined by an index (non-dimensional numerical value) obtained from the weighed matrix method that will be used. Quantitative indices classes are defined and to each one of these will correspond a qualitative vulnerability degree.

Table 3: Example for probable aquifer vulnerability

Index	Vulnerability	Colour (Map)
≥ 80	EXTREMELY HIGH	RED
70 - 80	HIGH	ROSE
60 - 69	MODERATE	YELLOW
50 - 59	LOW	GREEN
≤49	VERY LOW	BLUE

Periodicity: Bi-annual, for the parameter (*Depth to the water table*) with season variation. Annual average obtained from monthly averages of series of 30 consecutive hydric years, for the dependent of climatic variables parameter (*Recharge).*

Other indicators relationship: Groundwater quality.

Data Sources: Portuguese institutions – Instituto do Ambiente *(Environment Institute);* Instituto Nacional da Água *(National Institute of Water)*; Direcção Regional do Ambiente e do Ordenamento do Território do Centro *(Agency for the Environment and Territory Planning of Portugal Central Region)*; city councils; Universidade de Aveiro *(University of Aveiro)*; Laboratório Nacional de Engenharia Civil *(National Laboratory of Civil Engineering)*; Instituto Geológico e Mineiro *(Geological Survey of Portugal).*
German institutions - Saxony department for environment and geology

4.4.7 Stream sediment contamination

Emissions from contaminated sites like uranium mines and metallurgic and chemical industry affect the test site region. Contamination definition is measured according to Müller Geoacumulation Index and other appropriate vulnerability indices. The indicators for each phase of the DPSIR chain could be: D – uncontrolled and abandoned uranium mine works, chemical and metallurgic industry and tanning industry; P – untreated industry discharges in rivers, stream sediment heavy metal drained from mining tailings; S – stream sediment contamination; I – damage in local ecosystems; risk for public health; R – mining tailings stability; acid mine drainage control; industry discharge treatment.

Technological Hazard/Risk Type	Stream sediment contamination/Pandora
Indicator	Contaminated sediment
DPSIR model	State indicator

Short description: Stream sediment contamination is designated according to the quantification of various parameters analyzed in several specific points of the basin that exceed toxicity levels.

Methodology: Scanning of this indicator is based on data sampled and analyzed in a specified catchment basin dimension and its relation with background information of these sediments in the test area. Müller Geoacummulation Index, Ryan & Window (1988) normalisation data and other appropriate techniques will be used.

Relations with other indicators: soil and stream water contamination.

Origin of the data: Ferreira (2000) " Dados geoquímicos de base de sedimentos fluviais de amostragem de baixa densidade de Portugal Continental: Estudo de factores de variação regional". PhD thesis, Aveiro University and other scientific papers.
Saxony department for environment and geology, University of Dresden and Freiberg

Units of measure: Number and/or percentage of samples, where the values measured are above the limit-values established by vulnerability indices.

Technological Hazard/Risk Type	Stream sediment contamination/Pandora
Indicator	Uranium mines distribution
DPSIR model	Pressure indicator

Short description: Uranium mines generate materials not in chemical or physical equilibrium which reflects sensibility to pollution. Contaminated classification is defined by volume and dispersion of tailing materials, proximity to population centers and to rivers.

Methodology: Identification and mapping of uranium mining sites, chemical concentrations in relation to proximity to the mine, taking into account the relief, will enter in a evaluation criteria adapted from previous works and based on regional background values in stream sediments.

Relations with other indicators: soil and stream water contamination.

Origin of the data: Ferreira (2000) " Dados geoquímicos de base de sedimentos fluviais de amostragem de baixa densidade de Portugal Continental: Estudo de factores de variação regional". PhD thesis, Aveiro University and other scientific papers. Geological Survey of Portugal (IGM) "Relatório das Minas Abandonadas".

SIORMINP Mining sites database.
Saxony mining authority

Technological Hazard/Risk Type	Stream sediment contamination/Pandora
Indicator	Chemical and Metallurgic Industry Distribution
DPSIR model	Pressure indicator

Short description: Industry produces residues that without treatment generate local or regional pollution. Contaminated classification will be determined according to the impact in river ecosystem and public health.

Methodology: Identification and mapping of categories of industries, information about residues composition and chemical analysis of stream sediments in the industries catchment area, will contribute to the production of vulnerability indices.

Relations with other indicators: soil and stream water contamination.

Origin of the data: Ferreira (2000) " Dados geoquímicos de base de sedimentos fluviais de amostragem de baixa densidade de Portugal Continental: Estudo de factores de variação regional". PhD thesis, Aveiro University and other scientific papers. Regional Environmental Institution and Central Environmental Institute

Saxony department for environment and geology, University of Dresden and Freiberg.

4.4.8 Soil contamination

Emissions from contaminated sites like uranium mines and metallurgic and chemical industry affect the pilot regions. The indicators for each phase of the DPSIR chain could be: D – uncontrolled and abandoned uranium mining works, chemical and metallurgic industry, agricultural fertilisers and pest control products; P – untreated industry discharges in soils, dispersed materials from mining tailings; S – soil contamination; I – risk for public health; R – mining tailings stability, acid mining drainage control; restrictions in use of contaminated water in agriculture.

Technological Hazard/Risk Type	Soil contamination/Pandora
Indicator	Contaminated soil
DPSIR model	

Short description: Soil contamination is designated according to the quantification of various parameters analysed in several specific points related to soil type, land use, forest type and population density.

Methodology: Scanning of this indicator is based on data sampled and analysed in specific sites and its relation with regional background values in soils. Contamination will be defined according to limit values from the appropriate legislation used in other EU countries for public health and land use application.

Relations with other indicators: stream sediments and stream water contamination.

Origin of the data: Aveiro University, Geological Survey of Portugal(IGM) (exploration data); Research papers.

Saxony department for environment and geology: Saxony land register of historical burdens

Units of measure: Number and/or percentage of samples, where the values measured are above the limit values established by vulnerability indices.

Technological Hazard/Risk Type	Soil contamination/Pandora
Indicator	Uranium mines distribution
DPSIR model	Pressure indicator

Short description: Uranium mines generate materials not in chemical or physical equilibrium, which reflects sensibility to pollution. Contaminated classification is defined by volume and dispersion of tailing materials, proximity to population centres, proximity to agricultural land.

Methodology: Identification and mapping of uranium mining sites, chemical concentrations in relation to the proximity of the mines and tailing areas, based on regional background values in soils. Contamination definition will include several parameters already tested in the Diagnosis of Abandoned Mining Sites in Portugal and Saxony and will be also compared with available information from previous reports.

Relations with other indicators: stream water and sediments contamination.

Origin of the data: Geological Survey of Portugal (IGM)"Relatório das Minas Abandonadas", SIORMINP Mining sites database. Exploration data. Aveiro University, Central Environmental Institute
Saxony department for environment and geology: Saxony land register of historical burdens, Regional Planning authorities in Saxony

Technological Hazard/Risk Type	Soil contamination/Pandora
Indicator	Chemical and Metallurgic Industry distribution
DPSIR model	Pressure indicator

Short description: Industry produces residues that without treatment generate local or regional pollution. Contaminated classification will be determined according to the impact on public health.

Methodology: Identification and mapping of categories of industries, information about produced residues composition and chemical analysis of soils and proximity to industry will contribute to the production of vulnerability indices.

Relations with other indicators: stream water and sediments contamination.

Origin of the data: Aveiro University and other scientific papers. Regional Environmental Institution and Central Environmental Institute. Geological Survey of Portugal (IGM)

Saxony department for environment and geology: Saxony land register of historical burdens, Saxony mining authority

Even though in chapter 6 is stated that the Pandora type of risks shall not be approached by the project the risk regarding soil contamination do show a close relationship to spatial planning policy and shall thus be considered in further investigations. The reason is that the named types of soil contamination all originate from clearly demarcable source areas and cause predictable damage in more or less definable receptor areas. They thus constitute classical issues for spatial planning intervention e.g. in means of preventive land use management.

4.4.9 Other possible Risk/Hazards:

- Coastal erosion
- Coastal pollution
- Sea level rise
- Volcanism
- Soil erosion/desertification
- Stream water contamination
- Areas to mining subsidence

Indicators presented in the above text can be changed if data applicability proved to be useless for the purpose of the definition of vulnerability of the Hazards selected.

4.4.10 General information on hazard concepts in the Region of Itä-Uusimaa

Spatial planning in Finland consists of three levels: regional plan, general plan and detail plan. In each level of planning technological and natural hazards are taken into account. Natural and technological hazards are part of the framework for spatial planning and affect spatial planning. Natural hazards in Finland are generally mild. Occasional flooding of rivers and lakes and the Baltic Sea, as well as storms that damages forests and forest fires cause considerable costs but rarely cause casualties. Technological hazards are therefore considered a main cause of hazards.

In the region of Itä-Uusimaa there are two main sources of potential technological hazards: the large oil refinery and industry cluster in Sköldvik in Porvoo and the nuclear powerplant in Hästholmen in Lovisa. In the regional plan for Itä-Uusimaa the oil refinery and the nuclear power plant have a protective circular zone of five kilometres radius around them. Inside this circle the number of year round inhabitants is limited to 200 individuals. The possible need for safe and unobstructed evacuation of the inhabitants is included in the more detailed general plan and detail plan levels in the form of a functional and clear road network.

As far as natural hazards are concerned they are taken into consideration in the detail plan level, for instance in coastal development, where the number of buildings per length of coastline is fixed. In addition the distance from the shoreline is ruled at approximately 10 meters and the level of the floor of buildings is to be at a minimum of 2.4m above mean sea level.

4.5 Analysis of climate change studies applicable on European and regional level

4.5.1 Climate change

The Climate Change concept has been given different meanings. In IPCC (Intergovernmental Panel on Climate Change), Climate Change refers to any change in climate over time, whether due to natural variability or as a result of human activity.

Many external factors force climate change and can be both natural and anthropogenic. The concept of radiative forcing is used to describe the influence of external factors. It describes the influence a factor has in altering the Earth-atmosphere system energy balance expressed in Watts per square metre. The radiative forcings arise from changes in the atmospheric composition, alteration of surface reflectance by land use, and variation in the output of the sun.

Increased concentrations of greenhouse gases tend to warm the surface and are thus a positive radiative forcing. The forcing agents are well mixed and long-lasting. Increased concentrations of some types of aerosols tend to cool the surface and are thus a negative radiative forcing. Anthropogenic aerosols are short-lived with a strong regional signature since they vary considerably by region. The radiative forcing of aerosols is not fully understood regarding their indirect effect on clouds. Natural factors, such as changes in solar output or volcanic eruptions, can also cause both negative and positive radiative forcing. Forcing due to episodic volcanic events lasts only a few years.

According to IPCC, the warming over the last 100 years is very unlikely to be attributed to internal variability only, and reconstructed 1000-years climate data indicate that this warming is rapid and unlikely to be entirely natural in origin. Most of the observed warming over the last 50 years can be identified as attributed to anthropogenic greenhouse gases.

4.5.2 Climate modelling and the future climate

Complex physically-based climate models are needed to project future climate. Although the understanding of climate processes and their incorporation in climate models have improved, they cannot yet simulate all aspects of climate. Uncertainties are particularly associated with cloud and their interaction with radiation and aerosols. Confidence in the ability of these models to satisfactorily produce projections of future climate has nevertheless increased.

Human influence will continue to alter the atmospheric composition and a number of future climate scenarios have been based upon emission scenarios from the IPCC Special Report on Emission Scenarios (SRES). The SRES emission scenarios show an continued increase in radiative forcing through the 21st century. Global average temperature as well as sea level are projected to rise and with a much larger rate than observed during the 20th century. Global model simulations show a more rapid warming of land areas than the global average, which is projected to1.4 to 5.8 degrees between 1990 and 2100. Global average water vapour concentration and precipitation are projected to increase and larger year to year variations in precipitation over areas with increased mean precipitation. Due primarily to thermal expansion and loss of mass from glaciers and ice caps the global mean sea level is projected to rise 0.09-0.88 metres between 1990 and 2100.

4.5.3 Future Climate in Europe

Europe´s long coastline and several major inland seas such as the Mediterranean, the Baltic and the Black Sea are important factors shaping the numerous regional climates of the continent. The high mountain regions acts as physical barriers to atmospheric flows and is thus responsible for the substantial regional differences in precipitation patterns.

The climate system is global but global models give too coarse a picture to be of use directly on a regional basis. Different regional models are therefore developed to transfer results from Global Climate (GCM) models to a more detailed description of the region. The Rossby Centre at SMHI has recently finished a series of six GCM driven regional simulations using two GCMs (HadAM3 from Hadley Centre, Great Britain and ECHAM4/OPYC3 from Max-Planck Institute for Meteorology in Germany) and two SRES scenarios (A2 and B2). Results are depending on both emission scenarios and driving GCM. In all simulations the warming in northern Europe is largest in autumn or winter. In central and southern Europe the warming peaks are in summer. A general increase in precipitation, especially in winter, in northern Europe can be seen in all simulations. Scenarios for southern and central Europe show a decrease in precipitation in summer. The extreme daily precipitation increases even in most of the areas where the mean precipitation over time decreases.

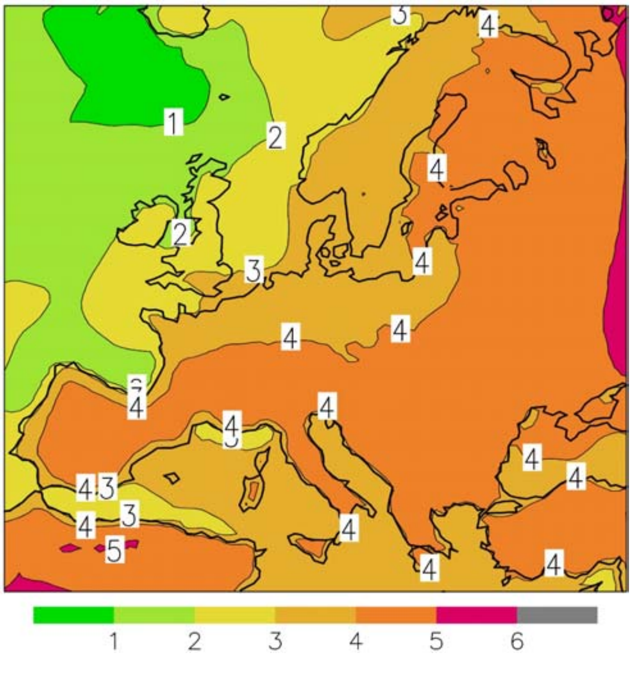


***Figure 7*. A regional projection of difference in annual temperature (degrees) between 2071-2100 and 1961-1990 as simulated by the regional climate model RCAO from Rossby Centre, based on a global simulation from the Hadley Centre and emissions according to SRES A2.**

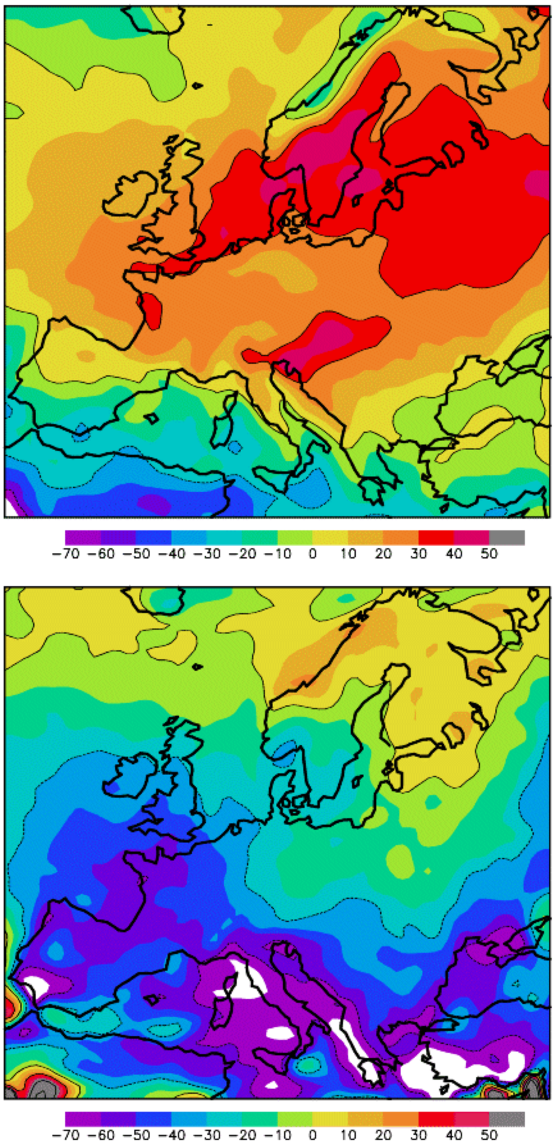


Figure 8. **Examples of simulated difference in precipitation (%) between 2071-2100 and 1961-1990 for the winter season /above and the summer season /below Simulated by the regional climate model RCAO from Rossby Centre, based on a global simulation from the Hadley Centre and emissions according to SRES A2**

4.5.4 Variability of climate and extreme weather events

Changes in external conditions, such as the ongoing increase in CO2 and other so-called greenhouse gases, may affect not only the mean state but also the variability of climate. Changes in extremes are affected by both. The response of simulated time-mean climate to increasing greenhouse gases has been studied extensively and the changes in mean temperature and precipitation tend to be addressed in all papers. Model-simulated changes in climate variability have been studied less comprehensively. There is now a trend towards an increased interest in climate variability and especially the occurrence of extremes.

Climate models project changes in daily, seasonal, inter-annual, and decadal variability. They also project changes in frequency, intensity, and duration of extreme events. More hot days, heat waves, heavy precipitation events, and fewer cold days are examples. There is currently insufficient information about small scale extreme weather events such as thunderstorms, hail, and lightning.

The IPCC Working Group I has defined an *extreme weather event* as an event that is rare within its statistical reference distribution at a particular place. Definitions of 'rare' vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile. By definition, the characteristics of what is called *extreme weather* may vary from place to place. An *extreme climate event* is an average of a number of weather events over a certain period of time, an average which itself is extreme (e.g. rainfall over a season) (*IPCC Working Group I Third Assessment Report Glossary)*

4.5.5 Changes in Extreme Events

Dooge (1993) gave on overview of the links between climate change and natural hazards (figure 9). The links are both direct, e.g. through an increase in extreme precipitation, and indirect as climate change may amplify the effects of other disastrous events. IPCC (2001) presented changes in extreme climate-related phenomena and their possible impacts on human life (Table 4). These are changes that have been observed, or are projected as likely by climate change models.

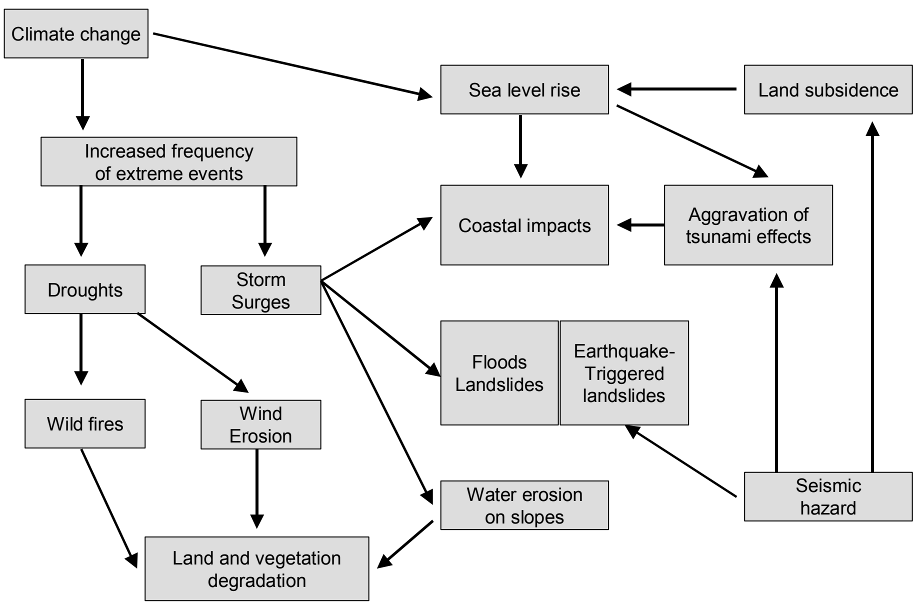


Figure 9. **Multidisciplinary links between climate change and natural disasters (Dooge, 1993)**

The increased interest in climate induced changes in extreme events is manifested in three projects supported by the European Commission under Framework Programme V Key Action “Global change, climate and biodiversity”, 2002-2005. The three projects - Prudence, Stardex and Mice - bring together expertise from across Europe in the fields of climate modelling, regional downscaling, statistical analyses of climate data and impacts analysis to explore future changes in extreme events, such as floods, droughts, coldspells, heatwaves and wind storms, in response to global warming. The projects aim at answering the following questions:

How will the occurrence of the extremes change?

What will the impacts be?

How certain can we be about our predictions?

The last question is addressed by using several different global and regional climate models as well as statistical downscaling of GCMs. The impacts will be evaluated on a European and regional scale, studying the changes through a number of indicators (Table 4). Case studies will be carried out for specific rivers and regions using runoff models, crop production models and regionally developed fire hazard indicators. It is clear that the results from these projects will be of vital interest in mapping the effect of climate induced changes in hazards in Europe.

References:

Dooge, James C. I. (1993): Climate Change and Natural Disasters: Where are the links? In: Bras, Rafael (Ed.): The World at risk: Natural Hazards and Climate Change. Cambridge, MA 1992. Cambridge, MA: AIP (= AIP Conference Proceedings, 277) pp. 13-21.

IPCC (2001) Climate Change 2001: Impacts, Adaption and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. ISBN 0 521 01500 6

Table 4. **Examples of extreme climate-related phenomena and their possible effects on hazards in Europe & indicators proposed for the Mice project**

Changes in extreme climate phenomena	Likelihood of occurring	Effects		Suggested indicators related to climate change
Temperature extremes				
Higher maximum temperatures, more hot days and heat waves	Very likely	Health	Increased incidence of death and illness in older age groups.	Number of degree days above 35^{o}C
		Electricity reliability	Increased electric cooling demand and reduced energy supply reliability.	
		Forest fire		Spring + summer rainfall below 50 mm, summer temperature above 25^{o}C
Precipitation extremes				
More intense precipitation events	Very likely	Flooding, landslides, avalanche and mudslide damage	For local events – flash floods in small rural and urban catchments. Regional events – flooding in main rivers	Number of days with rainfall above 20/30 mm. Longest spell of wet days
Increased summer drying	Very likely	Water scarcity		Longest spell of dry days
Wind extremes				
Increased intensity of mid-latitude windstorms	Little agreement	Effects on forests, electricity distribution and human settlements		Number of events with wind speeds above 17 m/s
Other extremes				
Increased intensity of storms may lead to increased lightning		Wildfires		
Sea-level rise. Increased mean sea level may increase the occurrence of tidal surges.		Coastal flooding		

5 DATA REQUESTS

5.1 Geographical and statistical background data

Statistical data

The first statistical data on population, GDP, unemployment and labor market has been received from project 3.1.on February 2003. The first data set includes following statistics and levels:

- Unemployment by sex and age NUTS 3
- Unemployment by sex and age NUTS 2
- Person employed by sectors and sex 1995-2000 NUTS 3
- Person employed by sectors and sex 1995-2000 NUTS 2
- GDP 1995-2000 NUTS 3
- GDP 1995-2000 NUTS 2
- Active population 1995-2001 NUTS 3
- Active population 1995-2001 NUTS 2

The metadata is included in separate files in this data set.

Geographical data

In the area of spatial planning, the political decision is classically based on the computation and mapping of regional indicators and indexes in the framework of territorial units. There is still a growing interest having an alternative way producing indexes in a continuous spatial framework, generally based on grid system. Useful information for the ESPON is produced and delivered on regular grid basis e.g. Corine Land Cover data by EEA and the UNEP-GRID.

Useful geographical data for the project 1.3.1 would be:

- Data Source Custodian
- Digital terrain model Gisco Eurostat
- Land cover CLC 1990 EEC (ETC/TE)
- Land use Lucas Eurostat
- Soil erosion risk EUSIS/EEA JRC (ESB)/EEA
- Soil types EUSIS JRC (ESB)
- Water pattern GISCO Eurostat
- Watersheds GISCO Eurostat
- Climate GISCO Eurostat

5.2 Data request to the EEA

This is a first data request that will be further elaborated in the course of the project

Data request to the EEA on the basis of the indicator assessment:

- Accidental tanker oil spills to the marine environment
- Nuclear waste production
- Progress in the management of contaminated sites
- Soil polluting activities from localised sources
- Tourism intensity
- Tourism arrivals
- Total waste generation
- Intensification of agriculture
- Input of hazardous substances (cadmium, mercury, lead, zinc, lindane and PCB7) into the North East Atlantic, 1990 and 1998
- Land take TERM 2002 08 EU+AC
- Fragmentation of land and forests TERM 2002 06 EU+AC

Conditional:

- Household number and size
- Generation and treatment of sewage sludge

5.3 Data request to the EuroStat and JRC

JRC, Natural hazards project (at this moment)

- European level forest fire risk maps
- European level rainfall-runoff maps

Table 5: Data request to Eurostat

DATA THEME DATA LAYER	DESCRIP-TION OF CON-TENTS	RESOLUTION/ SCALE	SPATIAL EXTENT	VOLUME (Mb)	COPYRIGHT AND SOURCES	REFERENCE CODE	STATUS	USE Project 1.3.1 proposals
		BASIC REFERENCE DATA (TOPOGRAPHIC DATA)						
1. Administrative Boundaries (AD)								
NUTS Regions EU (NU)								
Points version 7, level 0, 1, 2 and 3	Center point for NUTS region levels 0 to 3	1/1 000 000	Pan Europe	Between 0.03 and 0.07	CEC - Eurostat/GISCO derived from NUTS 1 million version 7, updated with boundaries from SABE 1997 and codes from Eurostat in 1999	ARNEV7PT	REF	Pie charts
	Used for labels, pie charts, etc.							

Commune boundary coverage (1997), 1 million	Boundaries of communes, ref. year 1997	1/1 000 000	EU15 + EFTA + 10 Eastern European countries link to the SIRE database available for 10 countries	118.8	MEGRIN/SABE + Eurostat/SIRE	CMEC1M97	CD SABE	General maps
Coast Lines	Coast Lines for pan Europe	1/1 000 000	Pan Europe	24	CEC - Eurostat/GISCO	EUCL	REF	General maps, flooding
Lakes	Lakes for pan Europe	1/1 000 000	Pan Europe	2	CEC - Eurostat/GISCO	EULK	REF	General maps, flooding
Digital Terrain Model Pan Europe, 3 million	Digital Elevation (altitude in meters) Grid for Pan Europe 30 seconds longitude/latitude resolution	1/3 000 000	Pan Europe	40	EDC, USGS	DEEU3M	REF	Landslides / avalanches
Urbanisation EU, 1 million, 1991	Classification of communes into 3 density classes: - Densely populated areas - Intermediate areas - Thinly populated areas	1/1 000 000	EU15	6	CEC - Eurostat/GISCO	UREC1M91	REF	Extent of damages
Nuclear power stations EU	151 reactors Attributes: capacity, type of reactor, energy production	Location of nuclear station	EU12	0.8	CEC - Eurostat/GISCO Eurostat, 1990 Operation of Nuclear power stations 1989	NPEC	REF	Techno-logical hazard
Electricity power and transformation stations Pan Europe	938 power and transformation stations Attributes: type, name, class	Location of station	Pan Europe	0.1	CEC - Eurostat/GISCO	EPEUEL	REF	Techno-logical hazard (e.g. dams)
Terminals and refineries for transport of oil and gas Pan Europe	256 terminals and refineries	Location of terminal/ refinery	Pan Europe	0.1	CEC - Eurostat/GISCO	ETEUOGPT	REF	Techno-logical hazard

Pan Europe	Attributes: type, name							
Pipelines and terminals/refineries for transport of oil and gas Pan Europe	Pipelines and terminals/refineries Attributes: type, capacity, status, name	1/20 000 000	Pan Europe	0.2	CEC - Eurostat/GISCO	ETEUOG	REF	Techno-logical hazard
Planned oil and gas lines and terminals eligible for the Trans European Networks Program Pan Europe	Planned oil and gas projects	1/20 000 000	Pan Europe	0.1	CEC - Eurostat/GISCO - DGXVII	ETEUOGTN	REF	Techno-logical hazard
Climate data base EU	19 climatic variables for 5 308 stations	Location of station	EU12 (except DDR)	2.4	CEC - DG XI/CORINE: obtained from Meteorological services of Member States	CTEC	REF	Climate related hazards
European interpolated climate data	Interpolated monthly climate data for 7 climate parameters	50*50 km grid cells	Pan Europe including Magreb	17	CEC - Eurostat/GISCO: obtained from MARS database	CIEU	REF	Climate related hazards
Inventory of land cover, Pan Europe	Inventory of biophysical land cover 44 class nomenclature (raster data)	250 m resolution	EU15 (except SE) + Some PHARE countries (LT, EE, LV, AL, PO, CZ, SV, RO, HU, BG, SI) + Parts of Morocco and Tunisia	36	CEC - Member States	LCEUGR250	REF	Forest fires
Inventory of soil units of EU, according to FAO nomenclature	15 843 polygons Soil mapping units and their characteristics; soil typological units and their characteristics	1/1 000 000	EU12	16	CEC - DGXI/CORINE and JRC-IRSA at ISPRA	SOIL	REF	Sensitivity of area
Inventory on coastal morphology and erosion risk, 100 000 scale	17 051 coast line segments Attributes: morphological criteria, evolutionary criteria, presences of manmade defensive structures	1/100 000	EC12 (except Greek Islands, former DDR, Madeira and Azores)	8	CEC - DGXI/CORINE	CEEC	REF	Erosion

5.4 Data request to the regional sources

5.4.1 Central Region of Portugal

Spatial planning response to natural hazards – floods/ forest fires

The general framework works either for the flood phenomenon and forest fires, even if what it presented here is related to flood hazard.

The following structure will present the hierarchy of accountable bodies for responding to these natural hazards (not only at a planning level but also at an operational level). The figurehead of each of them and the strategic document they comprise, are going to be mentioned as well.

1st Level – Institution: National Centre of Emergencies and Civil Protection (NCECP)

Scope of Action: National Territory

Accountable body/ Figureheads:

Planning body - NCECP depends directly on the Prime Minister of Portugal;

Operation level – NCECP guides the activities of the National Services of Fire Brigades (SNB) and the National Service of Civil Protection (SNPC)

Strategic Document: National Plan for Emergencies and Civil Protection

2nd Level – Institution: District Centre for operations of Emergency and Civil Protection

Scope of Action: District Area

Accountable body/ Figureheads:

Responsible – *Governador Civil* (Mayor of County Council)

Operation level - District Services of Fire Brigades and District Service of Civil Protection, which are being merged.

Strategic Document: District Plan for Emergencies and Civil Protection, plus special emergencies plans for flooding, fire forest and seismic activity, etc.

3rd Level – Institution: Municipal Centres of Emergencies and Civil Protection

Scope of Action: Municipal area

Accountable body/ Figureheads:

Responsible – City's Mayor

Operation level – town councillor for Civil Protection, the chief of Fire Brigades, the chief of GNR (police operating in rural areas), director of City council Infra- structures, director of EDP (Portugal Electricity Enterprise), director of the Red Cross, director of hydric resources of INAG, director of *Misericórdias* (Charity health and social care Institution)

Strategic Document: Municipal Plan for Emergencies and Civil Protection. This plan holds information on:

- Mission statement
- Responsibilities of each civil protection agent in case of accidents
- List of contacts of each one of those entities
- List of material and human resources within the municipal area (this includes private bodies as well)
- General characterizations of the main risks and the levels in which they have to mobilize the right agents according to the level of risk (green, yellow, orange and red).

In case of accident, the 3rd level is the first one that is responsible for mobilizing all necessary civil protection agents, and if proves to be insufficient due to the dimension of the phenomenon or due to the scarceness of human or material resources. They will be accountable for mobilizing the 2nd and, if necessary, the 1st level of this chain.

Flood hazards - Operation Level

The National Water Institute provides the district civil protection with water levels in a certain risk area

↓

The district civil protection warns the municipal civil protection

↓

Municipal civil protections warn and mobilize all the right agents, local radios and if necessary provide with personal warnings to those who live in risk areas

Forest Fires hazards - Operation Level

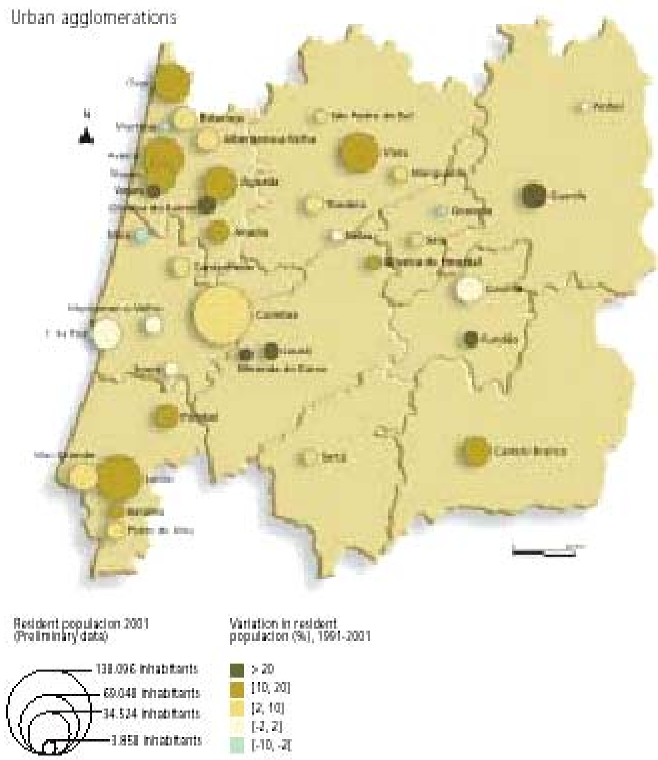
The National Institute of Meteorology provides the fire brigades with vulnerability indexes on fires (District Fire Brigades)

↓

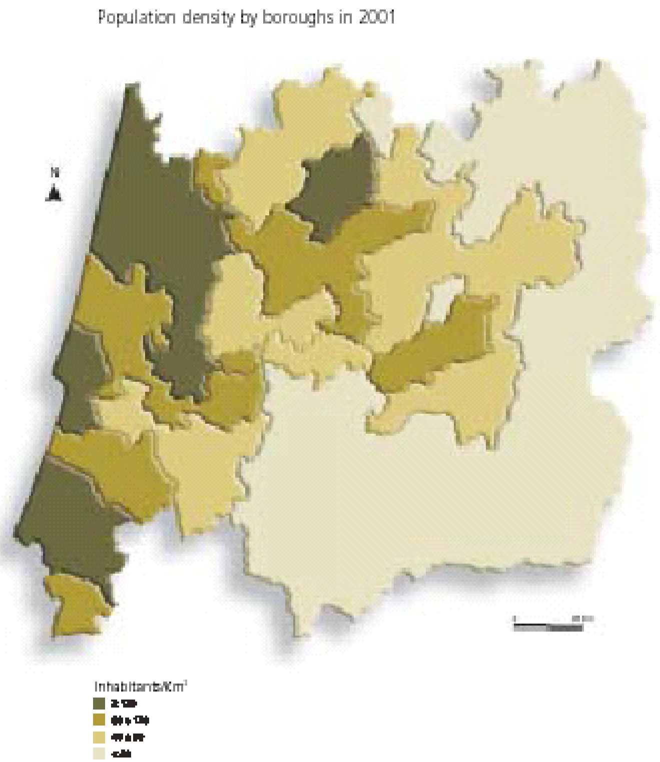
District Fire Brigades mobilize the right agents to cope with the dimension of the phenomenon, including the ones who are in watch posts.

If the above scheme responds the necessities of the other case-study areas it could be extended at an European level.

Map 1 – Centre Region Of Portugal – NUTE III



Map 2 – Urban Aglomerations



Map 3 – Population Density

Map 4 – Main Protected Areas

5.4.2 Administrative district of Dresden, Saxony

Regional sources for the data request (the origin scales of the data differentiate between 1:100.000 and 1:10.000):

- Saxony ministry for environment (1)
- Saxony department for environment and geology (2)
- Saxony department for statistics (3)
- Regional Planning authorities in Saxony (4)
- Saxony administration of storage reservoirs (5)
- Saxony mining authority (6)
- University of Freiberg (7)
- Institute of Ecological and Regional Development (8)

The following datas and maps do exist and are available:

- Map of protected water gathering grounds (out of 1)
- Map of flood areas (out of 1, 4 and 8)
- Map of ancient mining zones and subsidence areas (out of 5 and 6)
- Map of the risk of groundwater pollutions out of fertilizer and pesticides (out of 2)
- Map of mine waste tips out of uranium mines etc. (out of 6 and 7)
- Map of erodable areas (out of 4)
- Saxony land register of historical burdens (out of 2)
- Population density (out of 3)
- GDP per person (out of 3)

5.4.3 Associated case study regions

The three associated case study regions to 1.3.1 project, Itä Uusimaa in Southern Finland, Andalusia and a Region in Switzerland will probably submit dat request on a lter stage, depending on the possibilities of implementing the concepts developed in this project. Andalusia has already developed a large amount of indicators. For more information on the Regional Council of Andalucia, please visit the website http://www.cma.junta-andalucia.es/.

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6 FURTHER INVESTIGATIONS

This chapter gives an overview of a possible methodology for structuring the further investigation of the project. It outlines the selection of hazards, a systematic selection of indicators and the development of a typology of regions.

6.1 Methodology for the selection of hazards

There exists a wide variety of hazards which in some way can have effects on the development of regions within the European Union. But not all possible hazards will be of relevance in the context of spatial development. Therefore the relevant hazards have to be selected on criteria that fulfill the requirements within the range of ESPON projects. In the following the focus will be on the risk perspective instead of the perspective of the hazard concept. This broadens the possibility of describing the interactions between hazards on the one hand and the societal reaction and response to hazards (for example aspects of risk perception) on the other hand.

6.1.1 Selection criteria

The German Advisory Council on Global Change (WBGU) suggests the following criteria as a basis for the classification and characterisation of risks.

Table 6: Criteria for the selection of risks

Criteria	Range of values
Probability of occurrence *P*	0 to approaching 1
Certainty of assessment of *P*	Low or high certainty of assessment of the probability of occurrence
Extent of damage *E*	0 to approaching infinity
Certainty of assessment of *E*	Low or high certainty of assessment of the extent of damage
Ubiquity	Local to global
Persistency	Short to very long removal period
Irreversibility	Damage not reversible to damage reversible
Delay effect	Short to very long time lag between triggering event and damage
Mobilization potential	No political relevance to high political relevance

Source: WBGU 2000: 55

On the basis of the criteria mentioned above, risks can be classified into normal, transitional and prohibited areas of risk.

Risks in the ***normal area*** are characterized as follows (WBGU 2000: 42):

- Low uncertainty about both the probability of occurrence and the associated magnitude of damage,
- in total, a small catastrophic potential,
- in total, a low to medium probability of occurrence,
- low levels of persistency and ubiquity of risk sources or consequences,
- high reversibility of risk consequences should the damage occur,
- low statistical confidence intervals with respect to probability and magnitude of damage,
- no distinct distortions between the group that is exposed to the risk and the group to which opportunities and benefits accrue (distributional equity).

In this case a simple multiplication of the probability and magnitude of possible damage is appropriate. This approach permits risks and opportunities to be calculated against each other (WBGU 2000: 43).

Risks in the ***transitional*** or ***prohibited areas*** have at least one of the following characteristics:

- uncertainty is high for all risk parameters,
- the damage potential is high,
- the probability of occurrence is high, approaching 1,
- the certainty of assessment is low, but there are reasonable grounds to assume that major damage is possible,
- persistency, ubiquity and irreversibility are particularly high, whereby here too there must be reasonable grounds to assume that damage is possible,
- for reasons of perceived distributional injustice or other social and psychological factors, a major potential for mobilization is to be expected (refusal, protest, resistance)

When risks reach areas that are significantly beyond everyday levels, either the ‘transitional’ or the ‘prohibited area’ is reached (Figure 10). The transitional area calls for risk-reducing measures whose implementation promises a shift into the normal area. In the prohibited area the risks are so severe that generally a ban should be imposed, unless there is a consensus in society that these risks are to be accepted because of the associated opportunities (WBGU 2000: 43 f.).

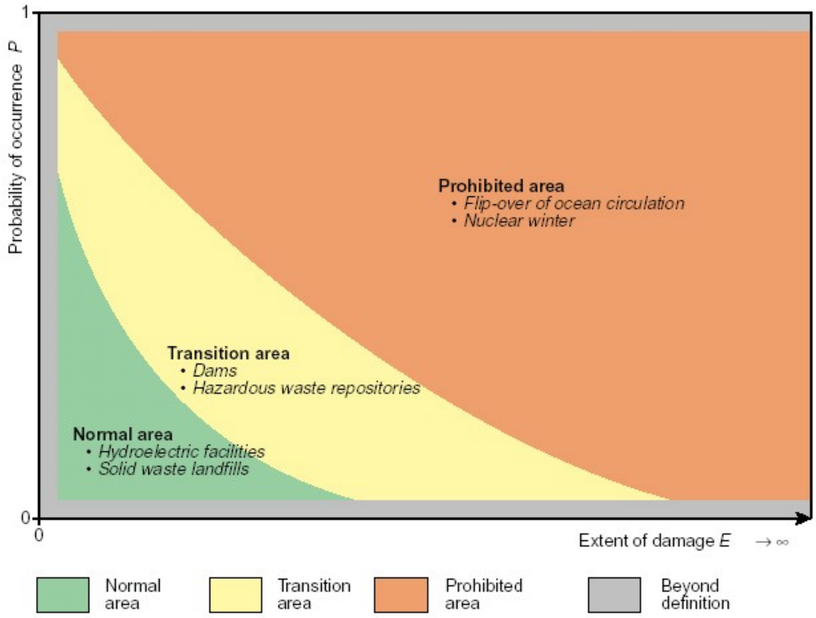

Figure 10: Normal, transition and prohibited areas of risks
Source: WBGU 2000: 44

6.1.2 First step of risk selection: risk type

Combining this display of risks with the criteria of Table 6 allows to identify different types of risks. This risk typology can be used as a first step to select relevant risks for the ESPON Hazards project. The following types of risk are characterised by the different values of the probability of occurrence (and the certainty of its assessment), the extent of damage (and the certainty of its assessment) as well as extreme values of other criteria such as high persistence, long delay of consequences or mobilisation potential (see Table 6). On this basis it is possible to distinguish six different types of risks (names are taken from Greek mythology; see Table 7).

Table 7: Overview of risk types: characterisation and substantive examples

Risk type	Characterisation *P* = probability of occurrence *E* = extent of damage
Damocles	*P* is low (approaching 0) Certainty of assessment of *P* is high *E* is high (approaching infinity) Certainty of assessment of *E* is high
Cyclops	*P* is unknown Reliability of estimation of *P* is unknown *E* is high Certainty of assessment of *E* tends to be high
Pythia	*P* is unknown Certainty of assessment of *P* is unknown *E* is unknown (potentially high)

	Certainty of assessment of *E* is unknown
Pandora	*P* is unknown Certainty of assessment of *P* is unknown *E* is unknown (only assumptions) Certainty of assessment of *E* is unknown Persistence is high (several generations)
Cassandra	*P* tends to be high Certainty of assessment of *P* tends to be low *E* tends to be high Certainty of assessment of *E* tends to be high Long delay of consequences
Medusa	*P* tends to be low Certainty of assessment of *P* tends to be low *E* tends to be low (exposure high) Certainty of assessment of *E* tends to be high Mobilisation potential is high

Source: WBGU 2000: 62

In short these six types of risks could be described as follows (descriptions are taken from the WBGU Annual Report 1998; WBGU 2000: 57 ff.):

Cyclops risk type

In classical mythology, the Cyclopes were one-eyed giants. With only one eye, only one side of reality can be perceived. Therefore, for this type of risks the probability of occurrence is largely unknown, but the possible damage is quantifiable. Such risks include natural disasters such as floods, drought or volcanic eruptions and epidemics or cancerogenic substances in low doses, but also the possible breakdown of the North Atlantic Stream (“Gulf Stream”) due to a collapse of the thermohaline ocean circulation, caused by anthropogenic climate change. An overarching strategy for this type of risk is to intensify research and monitoring in order to be able to better estimate in future the probability of occurrence and the possible damage. This is especially one aim of the ESPON Hazards project. Capabilities of affected parties to mitigate risks and international emergency preparedness arrangements also should be improved.

Damocles risk type

Damocles had to take a meal at a banquet while sitting under a sword hanging on a thread. For Damocles, opportunity and risk were closely linked. Therefore, in this type of risks, the possible damage can be very high, but the probability that it occurs is very low. In addition to meteorite impacts, many large-scale technologies can be assigned to this class of risk, such as major chemical works, mega-dams or nuclear power plants. For these risks, a three-pronged strategy is recommended: initially reducing the disaster potential through research and technical measures, then strengthening the resilience or robustness of the system against surprise and finally establishing effective emergency management procedures.

Pythia risk type

A further class of risk was named after the blind seeress of the Delphic Oracle, Pythia. Pythia's prophecies, while indicating that a possibly severe danger was on the horizon, left the precise circumstances in the dark, so that Pythia's answers ultimately remained unclear. In this risk type, both the possible damage and the probability of its occurrence are uncertain. Examples of Pythia class risks include genetic engineering interventions and the release of transgenic plants. In many cases, fund solutions are suitable for this class of risk, as it is scarcely insurable and the level of damage can assume global proportions. Above all, the Pythia class of risk calls for improving knowledge through basic research.

Pandora risk type

In Greek mythology Pandora's box contained evils that could do no harm as long as the box remained closed. As soon as it was opened, the evils dispersed throughout the world. Hence the prime concern in the Pandora risk type is the global dispersal of e.g. chemical substances and their accumulation in organisms. In many cases, the consequences of these risks are still unknown or there are at best assumptions concerning their possible damaging effects. Examples of this risk type include the pesticide DDT or endocrine disruptors. Here the development of substitute substances is recommended, restricting the application of persistent substances with unknown risk potential to manageable geographical and temporal scales, and spreading risk thinly by increasing the diversity of processes applied and substances used.

Cassandra risk type

Cassandra, a Trojan seeress, predicted defeat at the hands of the Greek, but was not taken seriously by her people. Nobody was willing to face the still distant threat. Therefore, in the Cassandra risk type, a relatively long period elapses between the causation and occurrence of harm. The long-term consequences of impending global climate change must be assigned to this risk class, as must the destabilization of terrestrial ecosystems due to the human induced change of biogeochemical cycles. As a strategy to counter this class of risks, a strengthening the responsibility of the international community for future generations through collective self-commitments and through promoting global institutions with a long-term perspective is recommended. This further involves informing the public about the consequences of inaction. To reduce these risks, emissions limits and the development of substitutes are suitable, but also tradable emission permits.

Medusa risk type

In classical mythology, Medusa was one of three cruel Gorgon sisters, whose sight alone made people turn into stone. Some novel phenomena have an effect on modern people in a way similar to that in which the Gorgons, as purely imaginary figures of fable, struck fear and terror in the hearts of the ancient Greeks. In the case of Medusa type of risks the public perceives hazards as being much larger than they really are. An example of this is the concern surrounding the cancerogenic effect of ionizing or electromagnetic radiation in low concentrations, which cannot be statistically proven. Here there is a need to build more confidence and improve knowledge in order to remove the remaining uncertainties, where possible. Ultimately, the affected people must decide themselves when weighing risks to what extent they give greater weight to the often poorly founded fears in the general public than to the proven damage potentials. Nevertheless, risk perceptions are a fact of life but they are strongly related to an individual perspective of risk which we have to exclude on a European wide level (see chapter 6.2).

These six types of risks allow to classify the risks and attribute them to the areas of risk (see Figure 11). The classification is not final as risks can evolve in the course of time from one class to another. For example, further research and a longer period of experience or the use of risk management tools might move a Pythia-type risk to the Cyclops type and from there towards the normal area (WBGU 2000: 63).

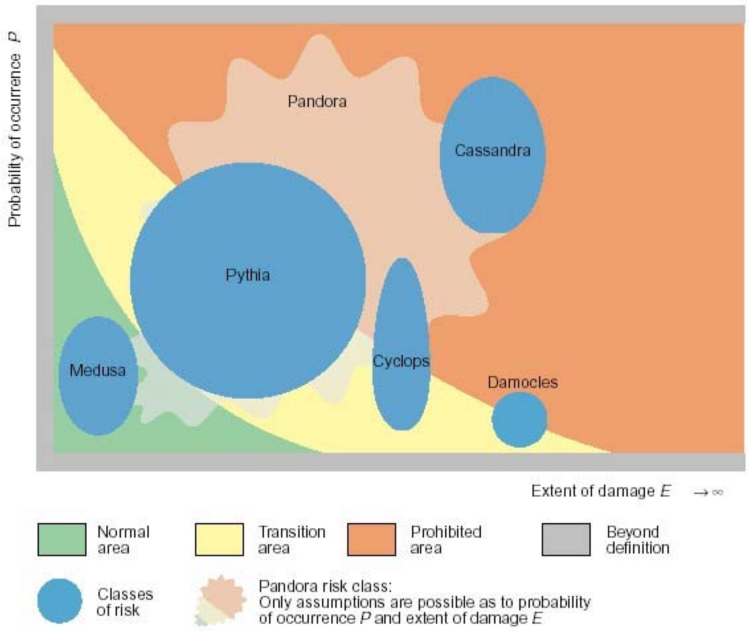

Figure 11: Types of risk and their location in the normal, transition and prohibited areas. Source: WBGU 2000: 62

This typology of risks can serve as the rationale for selecting the hazards to be investigated within this ESPON project. The risk type of Medusa is characterised by a high public sensitivity (mobilisation potential) and can therefore be tackled with improved risk communication. Hence it would not require a spatial planning response. Pythia, Pandora and Cassandra types of risks mainly belong to the prohibited risk area and are characterised by a high degree of uncertainty in regard to probability and damage potential or by a long time lag in regard to consequences. These characteristics make clear that these types of risks cannot be tackled by risk management in terms of spatial planning responses (although they might have negative spatial effects) but by integrated political and societal measures. Therefore, it is proposed not to further investigate the risk types of

Pythia, Pandora and Cassandra within the ESPON Hazards project. Spatial planning responses are mainly relevant for the risk reduction of the risk types of Cyclops and Damocles. Therefore it is suggested that only the risk types of Cyclops and Damocles should be taken into consideration within the ESPON Hazards project.

Note: The risks of long-term climate change as such belong to the Cassandra-type of risks. Therefore climate change as such will not be considered in this project. However, the important influences of the climate change on frequency and magnitude of several natural hazard will be considered (in regard to hazards that might be influenced by climate change like extreme weather events, e.g. floods or storms which belong to the risk types of Damocles or Cyclops).

6.1.3 Second step of risk selection: spatial filter

The categorisation of risks into certain types does not yet enable to extract from the great number of possible risks those risks that have relevance for the ESPON Hazards project. For example, murder, drug abuse or road accidents belong definitely to the main risks in western societies. But risks like these are not of interest to the Project because they have no specific spatial relation. Therefore, a second step for the selection of risks will be proposed: All the risks which will be taken into consideration within the ESPON Hazards Project should pass a certain risk filter in addition to the restriction to the risk types of Cyclops and Damocles: The *spatial filter* screens risks according to their spatial character. The spatial character can either be defined by spatial effects that might occur if a hazard turns into a disaster or by the existence of a spatial planning response.

Every hazard has a spatial dimension (they take place somewhere). However, spatially relevant is not yet spatial planning relevant. This also opens up questions about different levels of spatial planning (european, regional, local) – which calls for a discussion of what we mean by spatial planning in the project and does level/scale of planning have an effect on hazard selection? The following selection of hazards was made for a European wide level. Each case study for itself might reveal that also other risks will be of relevance for that specific case.

6.2 Preliminary selection of hazards

The following Table 8 evaluates existing risks on the basis of the *risk typology* and the *spatial filter*. The aim is to select those risks which are of relevance within the ESPON Hazards project.

Table 8: Evaluation and selection of risks on the basis of risk type and spatial filter

Risks / Hazards	Risk type (first step of risk selection)				Spatial filter (second step of risk selection)	Selection results (relevance for ESPON Hazards)	
	Characterisation of risk						
	Probability *P*	Extent of damage *E*	Extreme value of certain criteria	Risk type	Specific spatial relevance: + = high, o = low, - = none	ESPON-relevance?	Reason for exclusion
Volcanic eruptions	unknown	high	---	Cyclops	+	yes	---
Floods	unknown	high	---	Cyclops	+	yes	---
Landslides / avalanches	unknown	high	---	Cyclops	+	yes	---
Earthquakes	unknown	high	---	Cyclops	o	yes	---
Droughts	unknown	high	---	Cyclops	o	yes	---
Forest Fires	unknown	high	---	Cyclops	o	yes	---
Storms	unknown	high	---	Cyclops	o	yes	---
Extreme precipitation (heavy rainfall, hail)	unknown	high	---	Cyclops	+	yes	---
Extreme temperatures (heat waves, cold waves)	unknown	high	---	Cyclops	+	yes	---
Hazards from the collapse of thermohaline circulation (breakdown of the North Atlantic Stream)	unknown	high	---	Cyclops	-	no	does not pass the spatial filter
Nuclear early warning systems and nuclear, biological and chemical weapons systems	unknown	high	---	Cyclops	-	no	does not pass the spatial filter
Epidemics (e.g. AIDS infection)	unknown	high	---	Cyclops	-	no	does not pass the spatial filter
Cancerogenic substances in low doses	unknown	high	---	Cyclops	-	no	does not pass the spatial filter
Mass development of anthropogenically influenced species	unknown	high	---	Cyclops	-	no	does not pass the spatial filter
Hazards from nuclear power plants	low	high	---	Damocles	+	yes	---
Hazards from production plants with hazardous production processes or substances (large-scale chemical works, weapons, fireworks ore processing plants, etc.)	low	high	---	Damocles	+	yes	---

Hazards from hazardous waste deposits or the storage of nuclear waste or ore minig stockpiles	low	high	---	Damocles	o	yes	---
Hazards from the marine transport of hazardous goods (oil etc.)	low	high	---	Damocles	o	yes	---
Meteorite impacts	low	high	---	Damocles	-	no	does not pass the spatial filter
Instability of the West Antarctic ice sheets	unknown	unknown	---	Pythia	o	no	Pythia type risks have no relevance for the ESPON Hazards project
Self-reinforcing global warming (runaway greenhouse effect)	unknown	unknown	---	Pythia	-	no	Pythia type risks have no relevance for the ESPON Hazards project
Release and putting into circulation of transgenic plants	unknown	unknown	---	Pythia	-	no	Pythia type risks have no relevance for the ESPON Hazards project
BSE/nv-CJD infection	unknown	unknown	---	Pythia	-	no	Pythia type risks have no relevance for the ESPON Hazards project
Certain genetic engineering interventions	unknown	unknown	---	Pythia	-	no	Pythia type risks have no relevance for the ESPON Hazards project
Dispersal of persistent organic pollutants (POPs)	unknown	unknown	High persistence	Pandora	-	no	Pandora type risks have no relevance for the ESPON Hazards project
Endocrine disruptors	unknown	unknown	High persistence	Pandora	-	no	Pandora type risks have no relevance for the ESPON Hazards project
Long-term consequences of human-induced climate change	high	high	Long delay of consequences	Cassandra	o	no	Cassandra type risks have no relevance for the ESPON Hazards project
Destabilization of terrestrial ecosystems due to human induced change of biogeochemical cycles	high	high	Long delay of consequences	Cassandra	o	no	Cassandra type risks have no relevance for the ESPON Hazards project
Electromagnetic fields	low	low	High mobilisation potential	Medusa	o	no	Medusa type risks have no relevance for the ESPON Hazards project
Hazards along transport networks	high	low	High ubiquity	---	o	no	No relevance for the ESPON Hazards project due to high ubiquity

Source: ESPON Hazards 2003

On the basis of the criteria discussed in the above chapter, the following risks are of high relevance for the ESPON Hazards project:

natural hazards: volcanic eruptions, floods, landslides/avalanches, earthquakes, droughts, forest fires and storms;

technological hazards: hazards from nuclear power plants, hazards from production plants with hazardous production processes or substances, hazards from hazardous waste deposits / storage of nuclear waste / hazards from the marine transport of hazardous goods.

6.3 Towards a system of indicators for each hazard

For the attribution of indicators it will be important to construct a network of interrelations for every hazard that shows the driving forces, pressures, state, impacts and possible responses.

6.3.1 Structure of the indicator system

Regarding the literature on environmental and sustainability indicators one can find significant differences in the way indicators are connected to each other. The OECD uses the Pressure-State-Response framework (PSR) where indicators are closely connected to each other. That means that each of the environmental issues (e.g. climate change, ozone layer depletion, waste) is described by indicators of environmental pressures, environmental conditions (state) and societal responses. Those societal responses are closely connected especially to the environmental pressures (OECD 1994: 14). In other approaches, indicators are less connected to each other, like in the working list of indicators of sustainable development of the CSD which follows the Driving Force-State-Response framework (DSR). Here the response indicators often cover very broad aspects of response (CSD 1996). For the ESPON 1.3.1 *Hazards* Project it will be highly necessary that there is a strong connection between the indicators for Driving forces, Pressures, States, Impacts, and Response actions as natural and technological hazards are very specific and therefore also need specific response actions. The structure of indicators within the ESPON Hazards project could be as followed:

Table 9: Structure of the indicator system

Issue *Natural and technological hazards*	Driving forces *Indicators of influence factors on hazards and damage potentials*	Pressure *Indicators of hazards and damage potentials*	State *Indicators of spatial risk / spatial security*	Impact Indicators of disaster	Response *Indicators of disaster response / risk management (indicators of prevention, mitigation, preparedness, response, recovery)*
Natural hazards					
Volcanic eruptions					
Floods					
Landslides/ avalanches					
Earthquakes					
Droughts					
Forest fires					
Storms					
Extreme precipitation (heavy rainfall, hail)					
Extreme temperatures (heat waves, cold waves)					
Technological Hazards					
Hazards from nuclear power plants					
Hazards from production plants with hazardous production processes or substances					
Hazards from hazardous waste deposits / storage of nuclear waste					
Hazards from the marine transport of hazardous goods					

Source: ESPON Hazards 2003

The interconnection between the different indicators will be established by the formulating "story lines" for each indicator. These story lines, as used in the EEA indicator concept, establish relations to other indicators/groups of indicators and address policy relevance.

6.3.2 Filling the indicator system: the example of flooding

In the following, it is described how the indicators might be attributed to a certain hazard. This will be carried out at the example of flooding. The following Figure 12 shows the cascade of flood risk in relation to global change.

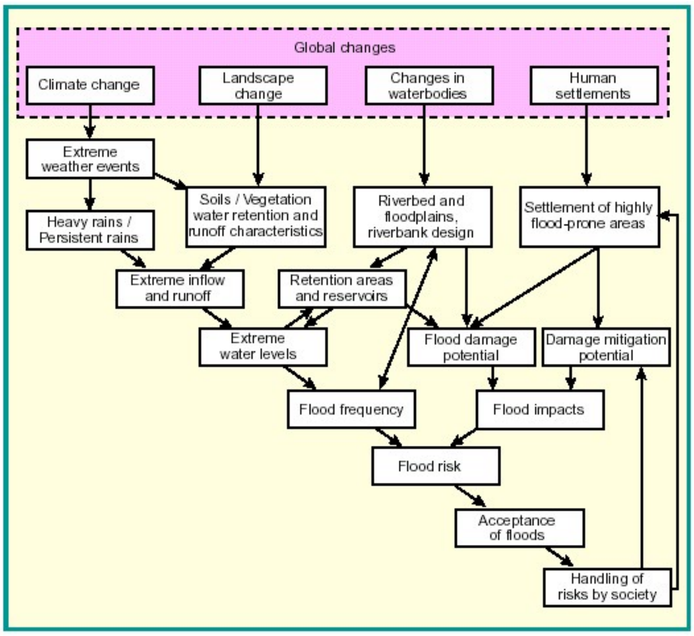

Figure 12: Cascade of flood risk
Source: WBGU 1999: 102

On this systems analytical basis of flood risk, the relevant indicators can be attributed to the model as the elements of the model in Figure 12 either belong to the Driving forces, Pressures, State, Impacts and Responses. The indicators should then be attributed to the categories as proposed in Table 10.

Table 10: The example of flood risk

Categories of Indicators Issue	Driving forces	Pressure	State	Impact	Response
Floods	Climate change Land-scape change Changes in water-bodies Human settle-ments	Extreme weather events Heavy rains / Persistant rains Soils / Vegetation water retention and runoff characteristics Extreme inflow and runoff Extreme water levels Settlement of highly flood-prone areas Flood damage potential Riverbed and floodplains, riverbank design	Flood frequency Flood risk Acceptance of floods	Flood impacts	Retention areas and reservoirs Damage mitigation potential Handling of risks by society

Source: ESPON Hazards 2003

This approach guarantees that the selected indicators really reproduce the risk of a certain hazard. Second, it is also possible to adapt spatial planning or other responses to the right spot in the system so that they can capture the appropriate effects.

Such systems analysis or causal model should be developed for each of the selected natural and technological hazards within the ESPON Hazards Project as a foundation for the risk indicator concept.

Note: The project is considering that, for the second interim report this system's analytical approach or causal model will be integrated into the chapter "Selected regional indicators" as a basis for the selection of indicators. For the example of flooding this would be the introduction of chapter 4.4.2.

6.4 Towards a typology of regions

On the basis of the selection of hazards and indicators outlined above it is possible to move towards the development of a typology of regions in regard to hazards. Because of the different nature of hazards such a typology will first be developed separately for each hazard. Each typology should take into account the expected frequency and magnitude of occurrence of the respective hazard in order to estimate the potential impact. Subsequently, the separate assessments for the individual hazards will be superimposed to reveal the most threatened areas in regard to *all* hazards. In addition, the data will be analysed to develop different risk profiles. These risk profiles, which will also include data on the management of risks, will then be presented in a cartographic form with their combined expected frequency.

The index of risks proposed in the previous section allows a typification of regions which integrates both the hazard potential and the vulnerability. The index allows to distinguish between those regions, which are only hazardous areas and those, which are risky areas, referring to their high degree of vulnerability. This methodology is based on the ecological risk analysis, an estimation method, which is being used as part of environmental impact assessments (Bachfischer 1978, Scholles 1997).

For both parameters only a small number of indicators should be used. First, if great care is taken in selecting the most relevant indicators they should be sufficient for estimating hazard potential and vulnerability with the necessary and possible exactness. Second, a greater set of indicators would lead to new methodological problems, especially in regard to weighting and aggregating the indicators. Therefore, in the following a small number of indicators for each parameter is identified and justified.

Vulnerability

To reflect the vulnerability of a region, it should b e sufficient to analyse the GDP per person and the population density. These indicators already catch a lot of factors, which have more or less influence on vulnerability: The GDP per person in combination with the population density stands for the economic damage potential (infrastructure, buildings, movable facilities), the technical response potential and the probable injury to people at the same time. Regarding the aggregation of both indicators, a simple addition and division by two can be justified and would generate a quantitative variable on a nominal scale which allows all kinds of statistical operations.

Coping capacity should then flow into the project in a qualitative way. As the result of the integration of coping capacity into our quantitative risk index probable some corrections regarding the ranking of specific regions will be necessary, if they have an extraordinary high or low coping capacity.

Damage potential

In most cases a disaster would not destroy the entire damage potential, but only a specific part of it. However, so far reference was always made to the total damage potential. Therefore it is proposed to develop a simple damage function (on NUTS 3 level), which would allow to determine for each hazard, which percentage of the total damage potential would most likely be destroyed as the consequence of an occurred hazard. These damage functions would be based on empirical studies about realised damages of disasters that happened in the past.

Aggregation of hazards

To determine the total hazard potential of a region is more difficult, because a lot of very different hazards, which threaten a region at the same time, have to be taken into account. On the level of a single hazard this is much easier: one could simply combine the frequency of occurrence of this hazard with the probable magnitude.

Due to the methodological problems of aggregation and in order to avoid the loss of information (e. g. the differences in threat and vulnerability of a region regarding different hazards) it is preferable to first develop a typology for each individual hazard. This could be done using the following matrix.

Table 11:Typology of hazard x

Intensity of hazard x (e. g. coastal floods)	**Degree of Vulnerability**				
	I	**II**	**III**	**IV**	**V**
I				Sicily*	
II					
III					
IV					London*
V				Zeeland*	Hamburg[1]*

Hazard indicators (weight 50:50):
Frequency Magnitude

Vulnerability indicators (weight 50:50):
GDP per capita Population density

Degree of vulnerability	*GDP per capita (EU-average = 100)*	*Population density (EU-average = 100)*
I	< 50	< 25
II	50 – 75	25 – 100
III	75 - 125	100 - 200
IV	125 – 175	200 – 500
V	> 175	> 500

The last table above indicates how the two vulnerability indicators could be classified. Due to the fact, that in Europe the differences in population density are greater than differences in GDP per person, it seems necessary to use different ranges (see table above).

An overall risk typology taking into account all hazards seems to be possible only on an ordinal scale. On the basis of the classification for each individual hazard one can sum up the respective values for each region and divide them by the number of hazards and present the results in a summary matrix as shown below.

1 The examples are only indicative to show how regions would be classified using the matrix

Table 12: Typology of regions

Average intensity of hazards	Average degree of vulnerability				
	I	II	III	IV	V
I					
II					
III					
IV					Hamburg*
V				Sicily*	Zeeland*, London[2]*

This procedure seems to be practicable and at the same time illustrative. However, it neglects the interrelations between hazards because scores for each hazard are simply added up to arrive at average values. A more sophisticated approach which would take due account of the interrelations between hazards (exacerbating and ameliorating effects) would be desirable, but only little scientific work has been done so far on aggregating different risks, let alone aggregating a great number of risks. More complex aggregation procedures which take into account interrelations between hazards would also remain beset with serious methodological problems which could actually distort the results. In any case, given these problems and the limited time and personnel capacity of the ESPON Hazards project the proposed simple aggregation seems to be the only feasible and justifiable procedure.

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[2] The examples are only indicative to show how regions would be classified using the matrix.

6.5 First ideas and draft guidelines on spatial planning for natural hazard risk reduction

The chapters 6.1 to 6.4 started a process to address the development of a vulnerability index, they point to the need of further studying vulnerability from the perspective of spatial planning. This is also relevant for the case study approach within the project. The question here is: How can we measure Institutional preparedness? We need to note, that it is difficult to estimate different hazards in many different regions. There is a clear need to create a synthetic index because hazard specific institutional preparedness is a huge task. Another point raised during 1.3.1's kick-off meeting concerned the response network notion; the network approach is difficult, how to measure organised network? Could regions be mobilised in networks faster? Is there regional preparedness?

6.5.1 Institutional preparedness/ institutional vulnerability

The issue of institutional preparedness/ vulnerability is part of what has been defined in the ESPON project as ***coping capacity*** (see Glossary, chapter 2.4), i.e. a component of vulnerability related to resilience of a community in relation to hazards.

From a social science perspective, vulnerability can be understood through the social (structural) causes that place people at risk and shape capacities to cope with, adapt to and recover from change. Institutional vulnerability points, hence, to the relative capacity of local/regional institutions in shaping the vulnerability of people's livelihoods.

In terms of institutional vulnerability and coping capacity, the role of spatial planning is a central concern for the ESPON project. Planning can be seen as crucial factor in reducing losses from disasters. According to Burby et al. (2000), land-use plans can be seen as statements of community goals, principles and actions. Integrating hazards into land-use planning can help a community through:

- intelligence about long-term (and unpredictable) threats
- problem-solving to cope with immediate threats prior to, during & after disaster
- advance planning to avoid or mitigate damage from a future diaster event
- management strategies to implement plans through policies

Burby et al. (2000) stress the importance of participatory practice in planning for hazard resilience. This has many simultaneous benefits such as stronger commitment to jointly agreed planning measures, the horizontal and vertical integration of a community (building social capital and concrete response networks), and better public awareness of hazards.

A starting point for a scheme on *planning-relevant coping capacity* could be the following observation by Smith (1992, 97), who sees that the main limitations on land-use planning as a means of reducing vulnerability are imposed by the following factors:

1. **lack of knowledge about hazards**
   - lack of knowledge about the type, location, recurrence interval and hazard potential of events which might affect specific areas

2. **costs of mitigation and hazard mapping**
   - mitigation measures may be costly, just as costs of hazard mapping, including detailed inventories of existing land use, structures, occupancy levels etc.

3. **existing saturated & extensive development**
   - presence of extensive existing development does not allow “room for maneuvre” for land-use planning

4. **declining awareness of hazards**
   - infrequency of most events and the difficulty of maintaining community awareness and avoidance of hazard-prone land

5. **social conflict & weak land use controls**
   - social, economic and political resistance to land use controls weakens the possibilities for effective planning

In other words, for land-use planning to be helpful as a coping strategy, regions and communities require 1) knowledge on hazards, 2) monetary & other resources, 3) open space for flexible planning, 4) public awareness of hazards and 5) legitimacy of the planning system, mutual trust /capacity to co-operate. The lack of these elements constitutes vulnerability while their existence in a region constitutes coping capacity and resilience.

Table 13. Regional coping capacity relevant to land-use planning (note: this is only tentative)

coping/ resilience component	operationalisation	main issues	possible indicators
1. knowledge	mainly qualitative	what knowledge of hazards exists? is this sufficient? (Note: this is also a challenge for the ESPON 1.3.1. project)	integration of hazards into plans, existence of local hazard assessments,
2. monetary resources	quantifiable	how much resources are available for mitigation efforts? how are resources distributed? (social vulnerability)	GDP/capita, inequality of income distribution, unemployment rate
3. open space	quantifiable	is there space available for hazard-sensitive planning? Note: areas with higher damage potential may have less benefits from spatial planning measures	population density, infrastructure density (built space/ total area), land cover
4. awareness	mainly qualitative	Are the local people aware of hazards?	existence of awareness programmes, media attention, level of education, GDP spent on education (?), environmental awareness indicators, existence of environmental NGOs & other organizations
5. planning capacity	mainly qualitative	How effective is planning? Are people committed to it? Are plans disputed? Are there powerful actors (e.g. developers) who neglect planning?	- level of participation in planning, existence of unplanned/unauthorized development, degree of local autonomy in planning in relation to national guidelines/ hazard mitigation plans

This table is only preliminary. A crucial aspect here is that the local vulnerabilities and responses to different hazards may come in very different constellations. The table presented above does not reflect the differences between hazards even if the elements listed are not hazard-specific. Hence, this needs further consideration. The minimum feasible solution is to choose indicators that reflect regional coping to all hazards. One relatively clear indicator for reducing vulnerability relates to the cost factor. Communities that are able to finance mitigation measures, hazard mapping, studies on local land-use, awareness campaigns etc. are clearly better equipped in dealing with hazards. In this respect, it serves to note that areas with high damage potential tend to have limited space available for benefiting from land-use planning as a measure for reducing vulnerability. What kind of planning practices are relevant for such locations? This should be looked at in the case study areas.

Another aspect to be included, though implied by the planning capacity element, are the different planning cultures in Europe, and the whole legal framework related to what planning is meant to do and what it can achieve. Also, national plans for hazard mitigation & their role in local settings should be considered. As to the latter respect, simple but useful indicators can be developped (i.e. is there a national/regional plan in place for hazard x) pointing to institutional vulnerability.

Here, risk perceptions can be seen as intertwined in the institutions and safety measures taken. Institutional risk perceptions, if realistic and sensitive, add to institutional preparedness. Risk perceptions may affect, for instance, the estimations on the probability of an emergency event (such as determining the frecuency of a flood: 1/50yrs... 1/1000yrs.). One way to look at risk perceptions might be through national level surveys on popular risk perceptions and environmental awareness. Based on uniform data over Europe, this can help indicate risk perceptions in different regions, contributing to and indicating (in a rather marginal sense, of course) regional and institutional vulnerability.

A futher consideration are the numerous fields of inquiry & practice that come close to spatial planning and have effects on it, which need to be taken notice of. For instance, financial tools (taxes, public & private insurance) provide incentives for construction etc. – which may be either congruent or counterproductive in relation to spatial planning.

In any case, institutional vulnerability needs to be studied also through case studies, which may provide a clearer picture of the above factors and their interlinkages at regional/local levels. On the basis of the framework above, specific questions can be formulated in the case studies, checking upon all of these aspects. The framework and relevant questions in this respect should be further developped. A common framework for the project is needed, since different partners will be dealing with different case study areas.

6.5.2 Compilation of good practices in the management of natural and technological risks with the help of case study areas

Overall, the ESPON programme (for good reasons) does not favor a case-based approach in their research projects. In the context of the ESPON 1.3.1 Hazards project case studies can, however, add important knowledge on different issues – which are beyond the methdological possibilities of aggregate EU-wide data.

1. Case studies shed light on the real-life interconnections between various factors relevant for risk management and vulnerability. This provides relevant information for the development of indicators and for testing their limitations, i.e. what indicators actually indicate.

2. The simple aggregate approach on different hazards neglects the interrelations between them. Hazards, at the local/ regional level don't just "add up", but are interconnected in various more dynamic ways – and, consequently, require dynamic response measures. There are serious methodological problems involved here. Hence, case studies can show what issues and mechanisms are relevant in multi-hazard settings (see "Further investigations" by IRPUD on the regional aggregation of hazards)

3. The idea of response networks, used in the ESPON tender, can be mobilized as a heuristic device in local case studies. This does not imply engaging in a thorough (not feasible) network analysis etc. at the local level but, rather, helping to point out the network-like constellation of local actors involved in risk management efforts. The idea of local networks refers directly to the notion of *social capital*, a candidate concept for operationalization & complementing the monetary approach. Another related issue is participation and community involvement. Participatory planning processes, for instance, help build networks and reduce vulnerability & help with both vertical & horizontal integration of actors in a community (see Tobin and Montz, 1997).

4. Further, case studies can provide information on historical developments in different regions. For instance, the recent experience of a hazard may explain heightened awareness thereupon and willingness to integrate it into planning. Often, the experience of a hazard provides a strong motivation for mitigation – but this is also contingent upon the local.

5. Unlike aggregate indicators, case studies allow studying how planning *processes* unfold.

6. Through the choice of cases, both best practice and failure can be highlighted and better understood.

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