ensure	**ENSURE PROJECT** *Contract n° 212045*

WP 2: Integration and Connection of Vulnerabilities

Del. 2.1.3:

Relation between social, economic and physical vulnerability

Reference code: ENSURE – Del. 2.1.3

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Short Description:

This document is about exploring the relationship between social and economic vulnerability at one side and physical vulnerability at the other. To explore this relationship a number of case studies of different types of hazards (earthquakes, floods, forest fires, landslides and volcanoes) have been reviewed and use is made of a conceptual framework adopted from public administration to describe policy processes.

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1. Executive Summary

This document is about exploring the relationship between social and economic vulnerability at one side and physical vulnerability at the other. The impact of physical vulnerability on social and economic vulnerability has been researched to quite some extent. However, the inverse relationship, i.e. how social and economic vulnerability influences physically vulnerability is less understood. Better understanding of this relationship will help to increase the effectiveness of decision-making in the field of physical and structural vulnerability for various types of hazards. The emphasis in this document is therefore on the impact of social and economic vulnerability on physical vulnerability rather than on the on rather than the impact of physical vulnerability on social and economic vulnerability.

To explore this relationship a number of case studies of different types of hazards (earthquakes, floods, forest fires, landslides and volcanoes) have been reviewed and use is made of a conceptual framework adopted from public administration to describe policy processes. Through this approach it was possible to identify the critical social and economic factors affecting physical vulnerability (initiation phase); the typical interventions to address physical vulnerability (implementation phase); as well as the blind spots in dealing with physical vulnerability. Eventually some of these factors and blind spots are linked to social and economic vulnerability, although these do not seem to be the overruling explaining elements of physical vulnerability.

2. Introduction

Task 2.3 "Relationship between social, economic and physical vulnerability", as part of Work Package 2 "Integration and connection of vulnerabilities", explores the relation between social and economic vulnerabilities on the one side and physical vulnerability on the other side. The work in this Task builds up on the definitions and understanding of the various vulnerability concepts discussed in the outputs of Work Package 1 "state-of-the-art on vulnerability types".

The objectives of the task are:

1. Improving the knowledge of physical vulnerability vs. social and economic aspects by identifying blind spots, weaknesses as well as functional and cultural misfits
2. Promoting awareness among decision-makers in implementing the gained knowledge in the field of physical vulnerability regarding various types of hazards.

The outline of this task is based on the interpretation of the original text of DoW and comments received from the various partners. Although the original task description suggested focusing mainly on building regulations; the eventual task has taken a wider scope, including other types of interventions directed at physical vulnerability.

DoW

"*….needs to explore the "Relation between social and economic vulnerabilities on the one side and physical vulnerability on the other side*'

"..physical vulnerability is inherent to structures, and therefore depends on how buildings are constructed"

"… should examine the much neglected interface between the physical components and the human or cultural element in the construction sector and their respective roles in contributing to physical/structural vulnerability"

Clarifying notes for WP2

"..On the basis of this analysis, this task will conclude with awareness raising suggestions for decision-makers implementing the gained knowledge in the field of physical and structural vulnerability vs. various types of hazards".

"……. it is important to understand how social factors, particularly those related to the efficiency of the public administration, the existence and quality of inspections succeed in enforcing building codes that may exist for certain hazards and/or avoid developing and creating exposure in dangerous sites "

The output of Task 2.3, which was led by ITC, is based on contributions from MDX, HUA, T6, UNIGE, TAU, POLIMI and PIK, with each partner contributing material that explicitly addresses objectives 1 and 2 above in relation to a particular hazard. The hazards addressed and the contributing partner(s) are listed below:

Droughts:	TAU
Earthquakes:	T6, POLIMI, HUA, BRGM
Land slides:	T6
Floods:	MDX, ITC
Forest fires:	PIK
Volcanoes:	UNIGE

The ultimate aim of this task was to raise awareness and give recommendations to decision-makers on how to deal with physical vulnerability. Part of the work includes an overview of the different intervention mechanisms that are in place to deal with physical vulnerability. The overview helps to understand 'what works' and 'what does not work'; and subsequently to understand which social and economic factors are at stake when dealing with physical vulnerability.

To structure the output, a policy cycle model has been adopted. The policy cycle model distinguishes three stages: 1. the Initiation stage; 2. the Implementation stage; and 3. the Evaluation stage.

The leading questions for these stages are:

Stage I: Initiation Stage

1. What are the social and economic factors that enhance physical vulnerability?

Stage II: Implementation Stage

2. What are typical mechanisms/interventions (public sector, private sector and civil society) to deal with the physical vulnerability for each specific hazard type ?

Stage III: Evaluation Stage

3. What are the key factors and 'blind spots' regarding social and economic factors/processes in the successful development and implementation of these typical interventions?

To answer the leading questions each partner provided material based on their hazard-experience, including:

- Examples of typical interventions (public, private, civil society) which are developed and implemented to deal with physical vulnerability.
- An analysis of specific cases regarding the extent to which interventions were successful/ unsuccessful in their development and implementation
- The social and economic factors that explain the successful/ unsuccessful development and implementation of these typical interventions.

To analyse the contributions and case studies, a methodological framework is formulated in Section 3. In Sections 4 to 9, case studies of droughts, earthquakes, land slides, floods, forest fires and volcanoes are discussed. Section 10 provides an analysis of the key factors that influence social, economic and physical vulnerability, identified in the hazard case studies. Finally, Section 11 offers decision-makers recommendations to deal with social and economic factors influencing physical vulnerability. Overall the relation between economic and social vulnerability on the one side, and physical vulnerability on the other shall be analysed.

3. Structuring the relations between physical, social and economic vulnerabilities

3.1 Methodological Framework

To discuss and analyse factors, vulnerabilities and interventions in the presented hazard cases a conceptual model has been adopted. This model is based on the policy cycle commonly applied in public administration to describe the policy process. The model consists of various stages, starting with agenda setting and concluding with the evaluation of a situation and/or process. After the evaluation, another process of policy-making may start again with agenda-setting. One of the most famous policy cycle models was developed by May and Wildavsky (1978).

The model consists of the following steps: Agenda Setting, Issue Analysis, Service Delivery Systems, Implementation, Evaluation and Termination. The first two steps belong to the Initiation stage: a situation is perceived as a problem and decision-makers want to act on it. Step three and four belong to the Implementation stage: a policy is being designed. The final two steps are meant to evaluate the policy and to judge whether it should be prolonged; adapted or terminated, i.e. the Evaluation stage. Based on this cycle, more authors formulated their own definitions of the different steps. Jann and Wegrich (2005) defined agenda-setting, policy formulation, decision-making, implementation and evaluation (Figure 1).

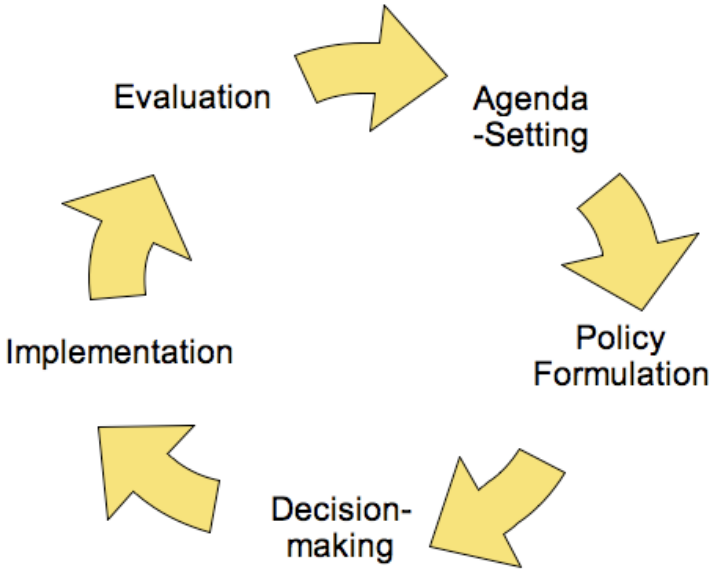


Figure 1: Policy Cycle based on Jann and Wegrich, 2005

To analyse our hazard cases, the policy cycle has been simplified into three general stages: Initiation, Implementation and Evaluation. During the Initiation stage the analysis focuses on the different factors and vulnerabilities that influence or are influenced by the hazardous environment. During the Implementation stage the interventions formulated and adopted are investigated. These interventions can be activated by public, private or civil societal (groups of citizens acting apart from public and private sector) actors. During the final stage, the Evaluation, the key factors and blind spots of a case will be identified and discussed, which form the basis for further recommendations to decision-makers. The three stages are shown in the analytical framework in Figure 2 below.

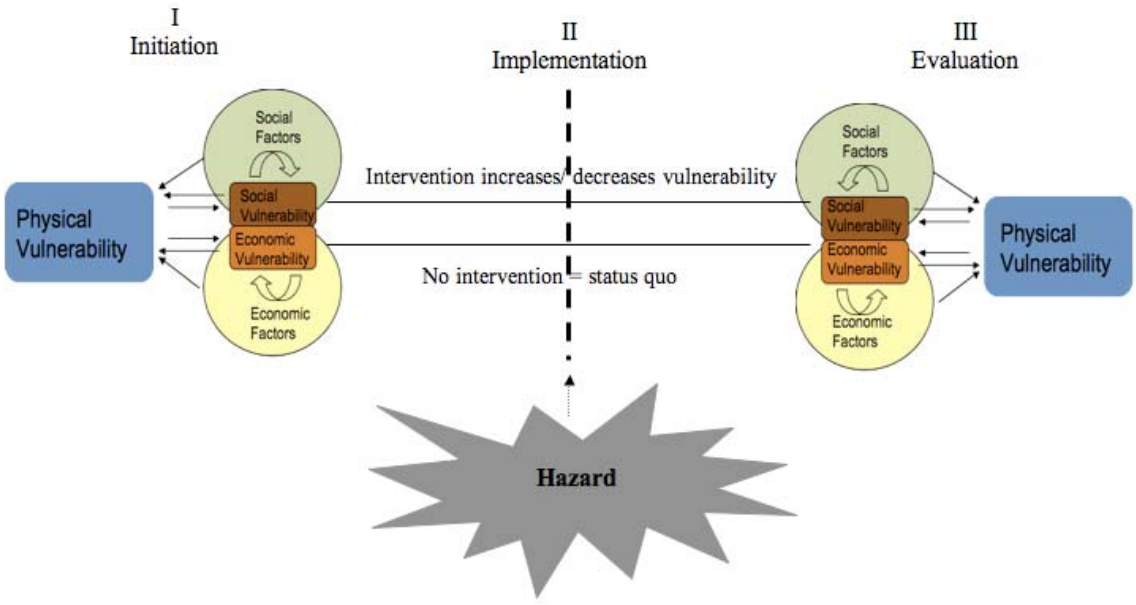


Figure 2: Analytical Framework of Vulnerabilities in a Policy Cycle (authors)

While formulating the analytical framework, the following assumptions were made. These assumptions are theoretical at first instance.

Assumptions Stage I: Initiation:

- Physical vulnerability influences social and economic vulnerability
- Social and economic vulnerability influence physical vulnerability
- Social and economic factors influence physical vulnerability
- Economic and social vulnerability results from economic and social factors

- Interventions attempt to influence one or more vulnerabilities
- All vulnerabilities need to be considered to increase coping capacity and resilience and to make interventions effective

Assumptions Stage II: Implementation:

- New policies are supposed to reduce vulnerabilities
- Effectiveness depends on
    - Awareness
    - Acceptance
    - Priorities
    - Implementation mechanisms
    - Who sets the agenda
- Intervention can be implemented by
    - Public sector
    - Private sector
    - Civil-society (groups of citizens acting apart form public and private sector)

Assumptions Stage III: Evaluation

- Social and economic factors remain constant (in a social system variables are supposed to be stable, except for the relations between the vulnerabilities)
    - Relations among vulnerability types may change

In Sections 4-9 these stages will be applied in the hazard case studies. In Section 10 a general evaluation takes place, based on the outcomes of the third stage in the previous sections. The evaluation will lead to recommendations to decision-makers in Section 11.

In the next paragraphs (3.2 to 3.4), the content of the methodology framework will be discussed in more detail. Theoretical examples of factors and interventions will be given.

3.2 Initiation: Definitions

The overall definition of 'vulnerability' that is adhered to in this task is "*the susceptibility to loss and the capacity to recover*". This definition could be further extended to the different types of vulnerability, i.e.:

- Physical vulnerability is the susceptibility to physical loss and the capacity to recover.
- Social vulnerability is the susceptibility to social loss and the capacity to recover.
- Economic vulnerability is the susceptibility to economic loss and the capacity to recover.

The **physical vulnerability** concept can be further specified and elaborated for the different types of hazards, as can be seen in Table 1 (further to be verified with task 1.1). Physical vulnerability clearly depends on the type of physical stress that arises from different hazards. This vulnerability

type thus cannot be generalized to all hazards, but is an intrinsic quality of any given object that depends on its resilience capacity to any given external shock.

	Physical Vulnerability Elements
Drought	Areas, soil, vegetation, crops and livestock affected by drought
Earthquakes	Areas, built-up structures and infrastructure affected by earthquakes
Flooding	Areas of development (urban, rural), physical layouts of developments; built structures; infrastructure (above ground, below ground) affected by water level rise. Physical vulnerability will occur in the area directly affected by floodwater, but may also extend beyond this area to surrounding areas.
Forest fires	Areas (incl. air quality), built-up structures and infrastructure affected by forest fires, forest ecosystems and other vegetated areas, enhancement of soil erosion processes, flooding risk down stream.
Landslides	Areas, built-up structures and infrastructure affected by landslides
Volcanoes	Areas (incl. quality of air, water and vegetation), built-up structures and infrastructure affected directly or indirectly by volcanoes

Table 1: Physical Vulnerability for Different Hazards

The concept of **social vulnerability**, has already been addressed quite extensively in work package 2.1 led by MDX. Social vulnerability was defined as being comprised of elements of human capital (i.e. skills, dexterity and judgment) as well as social capital (i.e. the value of social networks which affects the productivity of individuals and groups).

Economic vulnerability, then, is seen as a territorial area's susceptibility to exogenous shocks, which can be dampened by actors' choices that enable a given community to recover from or withstand the negative effects of such shocks. Economic resilience subsequently is defined as the policy-induced ability to recover from the effects of such shocks.

3.3 Initiation: Relations and causal links in the vulnerability framework

The vulnerability framework and its various concepts (vulnerability of different types, coping mechanisms and resilience) are very much interconnected. Below we have attempted to unravel these intrinsically related concepts to enable a better analysis and understanding of the various relationships.

The most important relationships and causal links that are being considered in the analysis of the interrelationships between physical, social and economic vulnerability are visualized in Figure 3. Not one single root cause or main cause-effect relationship can be identified. What follows is an attempt to enhance the understanding of the web and chains of relationships within the vulnerability framework.

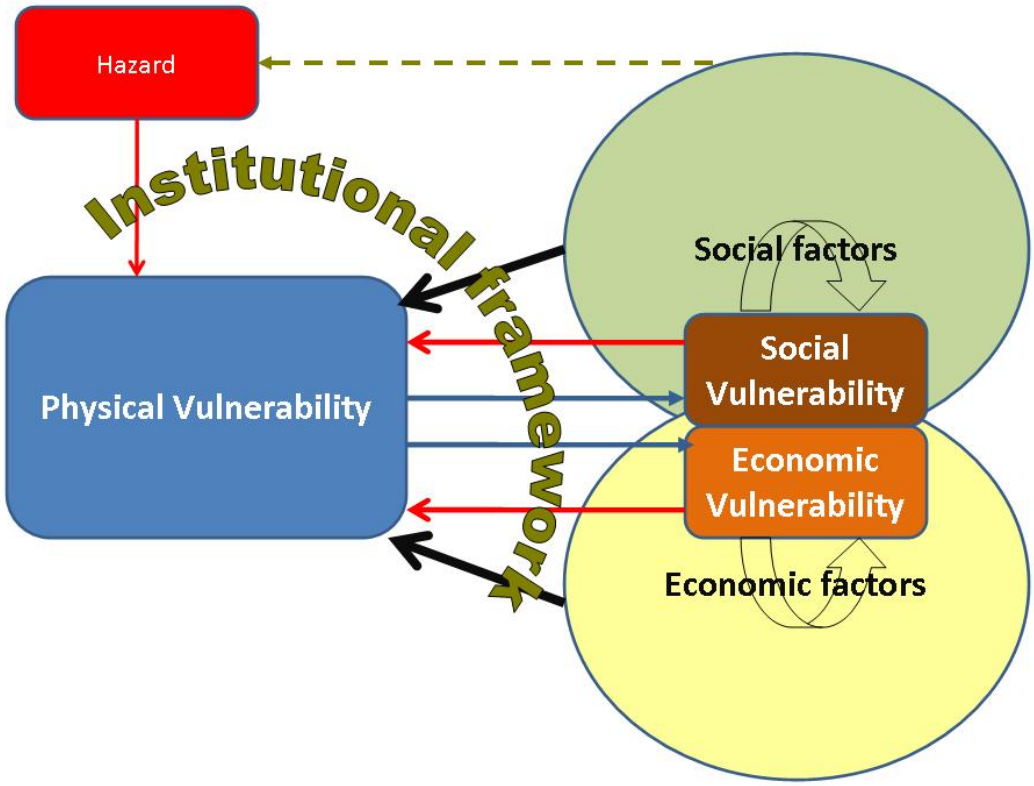


Figure 3: Vulnerability Framework

The meaning of 'hazards' in this delivery is not confined to 'natural hazards'. Volcanic eruptions and earthquakes are surely the result of natural processes, whereas for example floods do not necessarily occur solely naturally. Especially when putting a flood event into a wider time and spatial context, anthropogenic inferences such as deforestation or climate change have a clear impact on the 'natural' hazard. It is thus necessary to look for social and economic factors and their influence on such events. In this document hazards are not linked to social vulnerability through fatalities. Instead, physical vulnerability is perceived as a mediating variable, being intrinsically linked with economic and social vulnerability.

If the vulnerability of social groups and the economy is not at stake, i.e. if there is no evidence for social and economic vulnerabilities, physical vulnerability is irrelevant. Should that be the case, purely natural hazards are assumed. The impact physical vulnerability has on eco-systems and institutions could be added to this picture. But as eco-system vulnerability will not be considered here, and institutional vulnerability is thought to be an element of social vulnerability, this impact will not be discussed explicitly.

The direction of influence plays an important role. On the one hand, it could be physical vulnerability that influences social and economic vulnerabilities, e.g. when comparing the differential impact of a flooding event on small and medium-sized enterprises as compared to large companies. Or on the other hand, social and economic vulnerabilities may have an impact on and influence physical vulnerability. It is the latter direction, which will be the main focus of attention in this document.

The interest thus lies in the evaluation of social and economic factors and processes that do often determine who is most at risk and enhance physical vulnerabilities. For example factors that provoke somebody to settle in risky areas or to undertake economic activities in hazardous areas are considered.

A feedback loop is assumed to become evident when looking at the relationships between vulnerabilities. This is because the increased physical vulnerability that results from the various social and economic factors (black arrows) is expected to have an effect on the social and economic vulnerability of society as a whole, groups in society as well as on individuals (blue arrows).

A list with exemplary social and economic factors can be found at the end of this section. In this regard it has to be remembered that not all social and economic factors are equal to social and economic vulnerability factors and that it will be an important task here to identify those factors that should be considered as social and economic vulnerability factors. These could be factors such as low income causing families to settle in landslide hazardous areas because of low land prices.

Finally, intervention mechanisms have to be taken into account. Such interventions refer to mechanisms to cope with the enhanced physical vulnerability, i.e. mechanisms of coping capacity and resilience. Even though the definition already states that "vulnerability is the susceptibility to loss and the capacity to recover", intervention mechanisms are disentangled here from the vulnerability concept in order to be able to discuss and analyze them separately.

Intervention mechanisms can be found at four levels: in the public sector, in the private sector, and among groups as well as individuals acting in civil society.

Generally, a distinction between structural and non-structural mechanisms can be made, the latter of which refers to direct changes of behavior. Even though this differentiation is possible, in reality often a combination of both applies.

Consequently, the central aim with regard to interventions seeking to decrease the vulnerability to natural hazards is to:

a. Find out which social and economic factors are at stake (Initiation stage),
b. Examine the typical interventions to decrease vulnerability to specific hazards and their effectiveness (Implementation stage), and
c. Develop further insight about the relationship between physical vulnerability on the one and social as well as economic vulnerabilities on the other side (Evaluation), where the main focus in on the impact of social and economic vulnerability on physical vulnerability.

Influencing factors

Based on theory, a list of potential influencing social and economic factors was formulated. The list is used to get a general overview on how which factors can influence different types of vulnerabilities. Later, in the hazard cases, some factors will come back and will be complemented with others.

Public Sector:

- Structure of the Policy-Making Environment
  - Spatial Planning Approach; systematic versus diverse, as described by Fleischhauer (2006)
  - Stakeholder involvement: involvement of spatial planning authorities at different administrative levels,
  - Power relations: Influence of certain economic sectors on decision-making; e.g. possibility of the building sector to influence the granting of building permits
- Capacity of public sector
  - Experience with risk assessment and management
  - Capacity of local authorities to evacuate/ enforce/ protect/ guide rebuilding
  - Coordination between different governmental levels: lack of coordination may cause overlapping or vague responsibilities resulting in an ineffective emergency response (Wanczura , 2006)

- Common Practices:
  - Policy-decision on how to (re)construct buildings. As an example, in Greece (after the Mt. Parintha earthquake) buildings were reconstructed commonly in order to decrease the adversary effects of individual decisions on overall vulnerability (Sapountzaki & Dandoukali, 2006)

Private Sector:

- Culture of the business and private sector
  - sustainable business
  - transparency
  - anti-corruption
- Structure of private sector
  - Degree of competition
  - Monopolistic behaviour
  - Market size
- Land market
  - Land registration
  - Distribution public-private land
- Know-how
  - Research and development
  - Access to technology
- Role and functioning of the insurance sector (type products)
  - Possibility to insure against hazards
  - Risk perception

Civil Society

- Characteristics of the General Public
  - Awareness; possible unawareness due to infrequency of occurrence
  - Acceptance; increased through participation
  - Attitude towards participation; (Jarva & Virkki, 2006: 28f).
  - Beliefs and attitudes with respect to risk
  - Experience with hazards; enhances awareness; offers possibility for learning
  - Knowledge/ Information
  - Degree of organization though Non-governmental organizations of Community based organsations (CBOs)
- Characteristics of Individuals
  - Age: The elderly and children are said to be more vulnerable
  - Poverty:
    a. Insufficient financial reserves lead to higher mortality rate and more housing damage
    b. Poverty slows down recovery, and thus leaves the persons concerned more vulnerable to future hazards
    c. Extreme poverty may encourage the development of illegal housing in hazardous areas
  - Employment and location
    a. Living in hazardous areas because of possibilities to work; e.g. living in floodplains due to work opportunities

- Gender: Women more vulnerable than men; women are easier at risk of poverty; women more often have to take care of vulnerable groups
- Embeddedness: Tourists and minority groups more vulnerable due to lacking institutional and kinship embeddedness
- Owner/ tenant: owner more interested in hazard-fitting of houses as it is their own capital; tenants dependent on initiative of owners; owners possibly against awareness-raising methods as they fear a decrease in real-estate values
-

3.4 Implementation: Public, Private and Civil Society Interventions

An overview is provided of different intervention mechanisms that are in place and are applied to deal with physical vulnerability. This knowledge will help to enhance better understanding of 'what works' and 'what does not work', and subsequently to understand which social and economic factors are at stake when dealing with physical vulnerability.

As mentioned in the Introduction the leading questions for the contributions are:

1. What are typical mechanisms/interventions (public sector, private sector and civil society) to deal with the physical vulnerability of the hazard type concerned?
2. What are 'blind spots' regarding social and economic factors/processes in the successful development and implementation of these typical interventions?

In Table 2 an overview is given of the various hazards and the possible interventions. Some interventions are more relevant for one hazard than for another. Intervention for hazard might differ according to temporal dimension (e.g. drought: prolonged periods, no shock, high frequency).

	Physical structures	Land use planning	Building codes	Building permissions	Other regulations
Drought	√	√			√
Earthquakes		√	√	√	
Flooding	√	√	√	√	
Forest fire	√	√		√	√
Landslides	√	√	√	√	
Volcanoes	√	√	√	√	

	Economic incentives	Information and awareness mechanisms	Response measures	Private institutions	Civil Society Initiatives
Drought	√	√		√	√
Earthquakes		√	√	√	√
Flooding	√	√	√	√	√
Forest fire	√	√	√	√	√
Landslides		√		√	√
Volcanoes	√	√	√	√	√

Table 2: Interventions Dealing with Physical Vulnerability by Hazard

Intervention mechanisms could refer to prevention, preparedness, response as well as to information provision.

Examples of public intervention mechanisms are:

i. physical structures
ii. land use planning
iii. building codes
iv. building permissions
v. other regulations
vi. economic incentives
vii. information dissemination and awareness mechanisms
viii. response measures (incl. evacuation plans).

Examples of private intervention mechanisms can be found in the insurance sector and in technological interventions.

Examples of civil society intervention mechanisms include i) self-awareness; e.g. self-evacuation and ii) individual precaution; e.g. neighbourhood initiatives.

3.5 Public Intervention at the European level

Nowadays public intervention mechanisms are influenced by decisions taken on the European level, some examples of such decisions regarding natural hazards are given.

European regulation on Earthquakes

The European Committee for Standardization (CEN) is responsible for the issuing of Eurocodes; that are "common structural building and civil engineering structures" (CEN, 2009). With the introduction of Eurocode 8, by 2010 all national rules concerning the "Design of Structures for Earthquake Resistance" are replaced by a standardized European norm. The overarching aims of this norm are to protect human lives, to limit damages and to keep structures important for civil protection in operation.

European regulation on Floods

On the European level, Directive 2007/60/EC sets a framework for dealing with floods. In accordance to the subsidiarity principle (as set out in Article 5 EC), the Directive defines guidelines and overall goals but leaves their implementation to the different river basins as those are the management boards already involved in other European coordination attempts. The focus of the Directive is on the '3 P's' (Prevention, Protection and Preparedness; Recital 14 of the Preamble) and therefore a threefold path towards flood management is envisaged.

The first step is to undertake a Preliminary Flood Risk Assessment by December 22, 2011. This assessment includes mapping the river basin, reviewing its flooding history and giving an outlook to probable future events and their adverse consequences. The second step, to be finished by the end of 2013, is to draw Flood Hazard Maps showing the probabilities of floods and Flood Risk Maps depicting potential adverse consequences. Thirdly, by 2015 Flood Risk Management Plans shall be in place, which are to focus on the '3 P's' mentioned above.

Throughout the Directive the need for cross border coordination is highlighted, not only between Member States but also with third countries as natural hazards do not occur in accordance to national boundaries.

European regulation on Forest Fires

Also the natural hazard of forest fires is regulated on the European level. A basis was laid in 1992 with Council Regulation 2158/92/EEC on the protection of the Community's forests against fire. This Regulation has two main objectives: to reduce the number of forest fire outbreaks and to reduce the

extent of areas burnt (Article 1(2)). In order to do so, information systems shall be better coordinated, measures shall be evaluated and new activities shall be concentrated on the elimination of causes. Especially areas in Portugal, Spain, France, Italy and Greece are recognized as areas of high risk. For those areas, Member States are obliged to provide forest-fire protection plans which include a description of the present state of affairs and of the most recent fires as well as a statement on the objectives of the planning period and the measures applied to achieve them. Any Community funding as regards forest fire protection projects and programs is subsequently dependent on those plans. The scheme thus laid out was scheduled for five years, and thus follow-up regulations were necessary.

Already in 1994, Regulation 804/94/EC followed. It formulated rules for the application of the '92 Regulation. It is rather short and stipulates a minimum common core of information on forest fires, comprised of such data as the dates of alert, intervention and extinguishing. Council Regulation 1727/99/EC has the same aim as its predecessor and adds specific instructions on the make-up of national programs and the possibilities of funding. In the latest amendment, Commission Regulation 2121/04/EC, the competent bodies were further specified. Those bodies need to be governed by the law of one Member State; they shall offer adequate financial guarantees, operate according to the requirements of sound financial management and operate transparently (Article 1(2)).

Others

For the hazards of droughts and volcanic eruptions no regulatory framework exists on the European level. For both, decisions have been taken on emergency response measures under specific circumstances. So for example Council Regulation 787/98/EC allowed for special measures for Portuguese farmers affected by the 1992/93 drought and through Decision 2003/785/EC money of the Solidarity Fund was made available for citizens affected by the eruption of Mount Etna.

In the following contributions on different hazards will be presented.

4. Droughts[1]

4.1 Agricultural practices in the Negev

Two types of populations reside in the Negev, a Jewish and a semi-nomadic Arab (Bedouin) population. Both populations exploit the land, whether directly by cultivation or grazing or indirectly by feeding sheep or goats on hay and grains produced in the fields. While the Jewish sector cultivates the land in a very systematic, organized and sophisticated manner, the Bedouins, although using for the most part machinery, cultivate their land in a more traditional manner. While cattle and sheep are grown in enclosures in the Jewish sector, the traditional practice of open land grazing of sheep and goats is common in the Bedouin sector. These differences may largely stem from fundamentally different social structures.

Factors

The Jewish and Bedouin populations differ markedly in their social structure. On the Jewish side there are, Kibbutzim, a closed community advocating equality and the sharing of community resources in a more or less egalitarian manner, and Moshavim, a slightly more open community where only some of the revenue from resources is shared. On the Bedouin side, then, the population is either scattered or resides in towns. Most of the scattered part of the community reside either on disputed land, illegally on state-owned open areas, or in small towns - some of which were established spontaneously without legal foundations and therefore without infrastructure. Others however reside in one of the seven pre-planned towns where government provides the infrastructure and the municipal facilities.

Tradition plays a cardinal role in shaping the lifestyle of the Bedouin community.

Yet, during recent years the traditional family and tribal tradition has undergone some fundamental changes, not necessarily positive ones. Rich individuals who became wealthy through illegal means, such as drug dealers and other criminals, are now replacing the elderly as the new tribal authority. Conflict and violence between families of different tribes are common and the necessity of creating a 'strong' family may explain, at least partially, the high birth rate in the Bedouin community.

The birth rate within the Bedouin community is the highest in the world and the Bedouin population is doubling every 13.5 years. Polygamy is the rule rather than the exception. , relying on the Koran that permits marriage to four wives simultaneously. Yet, since the Shari'a (Islam's code of laws that is in use in Israel's Moslem communities), permits facile divorce. Very good medical facilities and government programs providing monthly income to families in accordance with their number of children contribute to a high birth rate (average birth rate of a Bedouin woman is $\pm$10 children).

As a consequence of high birth rates and the resulting economical burden imposed on the family, children often do not receive a full education (despite being mandatory up to 18 years) and enter the labor market when still teenagers. Poverty and crime is consequently very high. On the other hand, modernity and increased exposure to the more western-Israeli culture weakened solidarity, once high in the Bedouin sector.

Overall, while the education level and solidarity are very high in the Jewish sector, both are low in the Bedouin sector. Whereas commonly both parents work in the Jewish section, only one salary is available for a typical Bedouin family. Therefore, when an external hazard such as a meteorological

[1] Case material provided by TAU, Israel

drought hits the Northern Negev, the capability of both populations to deal with the subsequent agricultural drought is very different.

Vulnerabilities

If defining drought as a mainly socio-economic phenomenon resulting in "a substantial reduction in crop yield" (*cf*. Swearingen, 1992; Dalezios *et al*., 2000, Roberts, 2002; Tsakiris *et al*., 2007), any measure taken in order to increase crop yield may thus influence the physical and socio-economic vulnerability stemming from drought. Social factors such as solidarity or education may play a pivotal role along with economic factors. As a possible link between political and economic factors cannot be ignored, one may assume that social vulnerability may determine, to a large extent, the economic vulnerability. This is the case in many countries throughout the Mediterranean such as Greece (Katsoulis and Tsangaris, 1994), Italy (Piccarreta *et al*., 2004), Spain (Roberts, 2002; Fornés *et al*., 2005) and Morocco (Swearingen, 1992). Israel is no exception, as evidenced in the Northern Negev, where droughts, stemming from a substantial decrease in precipitation, may occur regularly once every few years.

Stage II: Implementation

Public Intervention

Public intervention in Israel is high. Owing to the high solidarity under which the state was created and owing to socialist views that were dominant during most of the 20th century national programs and numerous local enterprises for drought mitigation were set up. In what follows, and also described in Table 3, some of these enterprises will be discussed:

a. The demarcation of a '**drought line**' was undertaken in 1964 in order to provide a viable solution for farmers who lost not only their possible revenue but also their investment after a drought. The area demarcated includes the Northern Negev between the rain isohyets of ~250 to 450 mm. Being prone to droughts at a relatively low frequency of occurrence of once in a few years, the government passed 'The Drought Law' that guaranteed the reimbursement of the farmer's expenses during drought years. A joint committee of the government in collaboration with the Association of Farmers declares drought years following a meteorological drought during which precipitation was too low to allow for any meaningful crop yield. Once a drought year is declared, the committee samples the yield from different areas and based on their result and the revenue expected. The government then pays the farmers the difference between the expenses and the revenue obtained. In this way, the farmer's and settlements' financial collapse is prevented and field abandonment is avoided. For several years, some compensation to farmers with fields below 250 mm isohyets was also provided.

b. Aiming to provide drinking water to all inhabitants and for the same price, **the National Water Carrier** was designed in the early 1960s. It connects the relatively wet part of the country in the north (the Sea of Galilee) to the Northern Negev Desert. From the 1960s until the late 1980s some of the water was also used for agriculture. Yet, with the growing population and the higher frequencies of droughts, this water is now almost solely used for drinking purposes.

c. An example of **water purification** is the water purification plant of the metropolis of Tel Aviv (The Shafdan). The level of purification is one of the highest in the world and the water is safe for occasional drinking. All crops including green leaves such as parsley can be irrigated with this water. It reaches over 80% of all settlements in the Northern Negev. Other examples are local purification installations whether large, such as the sewage of cities of Jerusalem and Beer Sheva, or small, such as the sewage of the Kibbutzim and Moshavim. During the last three years, all water is purified to a high level that facilitates irrigation of vegetables such as potatoes and carrots.

d. The construction of **water reservoirs** aiming to catch runoff water that enters wadis (arroyos) such as Shikma, Gerar, Lachish and Nizzana. The water caught is used for irrigation. The Jewish National Fund (JNF) is highly involved in reservoir construction.

e. An infrastructure of **professional services** including agronomists and researchers as well as laboratory facilities was set up. Associated with the Ministry of Agriculture, these professionals are involved in providing free advice (the agronomists) or low-cost services (laboratories) in order to improve production. The Ministry of Agriculture is also involved in providing food for the Bedouin herds, e.g. during droughts. The Ministry is looking for grazing permits in Kibbutzim and Moshavim and in army firing zones that are usually closed to the public. In addition, the JNF provides free access to its forests in the south and central parts of the country. Bedouins are allowed to enter the forests, each herd owner to a specific area, following a contract agreement according to which the herd owners are committed to follow strict behavior codes in order to minimize damage to the forests. Access to the JNF forests is provided regardless of droughts. The payment requested by the Bedouins is about 0.5 euro for each sheep for the entire grazing period of approximately three months and thus rather symbolic.

Type of Intervention	**Extent**	**Description and Remarks**
The Drought Law	National/Regional	Aiming to prevent land abundance
The Water Carrier	National	Aiming to facilitate countrywide settlement
Sewage purification: Shafdan	National	Aiming to switch the drinkable water for agriculture with purified sewage water
Sewage purification	National/Regional	
Water Reservoirs	Regional	
Utilization of Ancient Saline Aquifer	Regional	
Agricultural Infrastructure	National	Aiming to spread new techniques of water irrigation, cultivation, seed varieties, deceases etc.
Sea Water Desalinization	National	Aiming to increase

Table 3: Public Intervention Dealing with Physical Vulnerability

In this regard, it is interesting to note that while a large scope of measures were taken in Israel much fewer measures were taken by European countries, as can be seen in Annex II: A comparison between Israeli and Spanish water use categories.

Private Intervention

The private sector is highly involved in the attempts to ameliorate production. Several industries exist that specialize in the production of irrigation equipment. One of them is Netafim. It is located in the Northern Negev and developed the drip irrigation system that is gaining more and more popularity in the world. This is due to the high proportion of water saved, the capability of using the system for concomitant fertilization and its advantage in minimizing soil salinity and plant decease. Recently, a new generation of subsurface drip irrigation was developed. Buried at 7 to 30 cm below the surface, it minimizes evaporation while still permitting the use of machinery (Tal, 2006). Certain companies have produced sophisticated data loggers to control irrigation while other companies have developed sensors, attached to trees that monitor the water status of the tree and automatically control its irrigation. Other companies have developed specific machinery aiming to improve the water storage of the soil (used in Kibbutz Ruhama) while others have produced sensors, attached to cattle, aiming to improve milk production.

Civil Society Intervention

A constant and ongoing effort to combat droughts is taking place in the Jewish sector. For this purpose, some Kibbutzim combine their means of production in order to reduce expenses. This is the case with Bet Kama and Mishmar HaNegev. All heavy machinery is jointly purchased and one Kibbutz member is in charge of all field production. Following research done by the Ministry of Agriculture and following results that showed that no-tillage cultivation may save on water and thus increase crop production, special machinery was purchased in order to facilitate seed insertion into the non-tilled soil. The cost of this machinery was twice as high as conventional machinery. Yet, by trial and error, specific changes were necessary and consequently executed in order to adapt the machinery to the local soil conditions. Furthermore, both Kibbutzim joined hands and decided to utilize the sewage water of the nearby Bedouin town of Rahat. While the sewage water is free, the condition of acquiring the water necessitated both Kibbutzim to build the infrastructure for storing and distributing the water in accordance with the crop need.

Similarly, all 34 Moshavim in the Negev decided to jointly cultivate some of their fields. This includes crops that are better cultivated in large fields such as wheat, potatoes, carrots and sunflowers, as well as citrus orchards. The individual Moshav farmer will mainly focus on cultivation in greenhouses located near his home while a private firm will jointly cultivate the majority of the fields, which are ar a distance from the residential area.

Kibbutzim and especially Moshavim invested in greenhouse construction. As individual farmers need a steady income in order to receive loans for greenhouse construction, it is easier to cooperate to jointly obtain the required guarantees. It is thus the community that jointly works towards better conditions and easier access to the necessary capital.

Whereas the use of purified sewage water facilitates irrigation also during severe droughts and thus allows for good crop yield, crop yield per cubic meter of water is most efficient in greenhouses. Both measures enable a successful drought management, facilitating drought mitigation and even drought 'avoidance'.

Non-profit organizations are involved in trying to improve crop yield and consequently to successfully combat droughts. One of the most powerful organizations is the Association of Farmers. It is not only involved in the receipt of the 'drought law' and in the decisions regarding money compensation for farmers during droughts, but also in other projects aiming to expand research and hence knowledge regarding agriculture under conditions of high water stress and low predictability. One of the projects that they are involved in, entitled 'Punctual Agriculture', entails the receipt of six to ten remote sensing images of crops in the Negev Desert during a single growing season. These images are analyzed to a resolution of a tenth of a hectare in order to detect areas short of water or nutrition and thus offer immediate remedies for these fields.

Stage III: Evaluation

Key Factors

Although both sectors, the Jewish and the Bedouin, have free access to agricultural agronomists, provided by the Ministry of Agriculture, the Bedouin sector is taking far less advantage of this service. Consequently, basic guidelines, such as cultivation in accordance with topographical contours are not always followed, bringing about not only erosion but also water loss due to runoff. No-tillage agriculture is not implemented while only limited adjustments are made for use of more efficient water-consuming crops, such as barley, instead of the traditional wheat. Machinery that promotes the increase of surface storage is also not used in this sector.

Only few Bedouin farmers abandoned the traditional practice of growing sheep and goats via open-field grazing. Apart from heavily relying on nature for adequate food supply, this traditional practice has additional drawbacks, as it highly complicates the use of sheep or goats for diary production and

thus substantially reduces the revenue obtained from the herds. Recently, herd owners face an additional problem as their children attend school and refuse to wander with the herds. While only few adopted the modern method of growing the herds in enclosures, others abandoned this profession altogether and moved to towns.

Field cultivation by Jews not only has positive consequences such as drought 'avoidance' or drought mitigation, but may occasionally have negative consequences. The use of heavy machinery may trigger soil compaction resulting in runoff and soil erosion. Runoff production reflects a net loss of water within the soil column, intensifying the consequences of the drought. Furthermore, the attempt to grow industrial plants such as cotton, which require large amounts of water, was unsuccessful when the water used was of low quality. Thus, in Kibbutzim like Kefar Aza, relatively saline water from a Pleistocenic aquifer was used. Although suitable for cotton growth, the high input of salt caused huge structural damage to the soil and to future crops. Not having better quality water on hand, this was one of the reasons that led to the cessation of cotton growth in the area.

Blind Spots

Weakened communal bonds and low income per capita tremendously lower the coping capacity of the Bedouin sector. Pan-Arab nationalism and ethnic pride within the Bedouin community make Jewish intervention problematic and thus assistance, to say the least, is not always welcome. The Bedouins do not assemble in civil associations and do not provide the initial capital needed for new enterprises. Heavy machinery that may be too costly for the individual but can be purchased by joint entrepreneurial efforts is not purchased due to the lack of solidarity and/or capital. Thus far, our research did not point to any 'real' and specific measure taken by this sector in order to better cope with the drought hazard. However the Bedouins do benefit from some measures taken by the state and by the private sector. Thus, those of them who have irrigated fields benefit from some of the water facilities and techniques and the development of new varieties of crops that are better adapted to dry conditions.

5. Earthquakes[2]

5.1 Socio-economic factors affecting physical vulnerability[3]

5.1.1 Stage I: Initiation

In the literature and in evaluations of several past disastrous events, impacts of infrastructural failures on the socio-economic structure of affected areas have been broadly studied. The scale of those impacts can be evaluated according to the number of affected infrastructural systems and the recovery period. For instance, when the impacts are minor, a short-term disturbance in social environment and limited negative impacts on certain business units can be revealed. On the other hand, in large-scale events, these impacts go through inconvenience with associated stress and conflict in community and economic tension at regional or national scale (Centre for Advanced Engineering, 1997). Concerning the physical environment or built-up environment, which is a product of socio-economic milieu, it is possible to find some traces on this mutual relationship which either increase or decrease vulnerability. Socio-economic structure of a region or a country comprises population size and distribution, demography, migrants, fiscal power, dependency/independency of the system, income distribution, national economic indicators etc. These invisible components become visible in the form of built-up environment. The socio-economic system shapes the quality of the physical environment, such as the redundancy of critical facilities and the response and recovery processes after crises.

[2] Case material provided by T6 and POLIMI, Italy and HUA, Greece
[3] Contribution by POLIMI

Consequently, if a socio-economic structure has vulnerable spots embedded, there will be some reflections on the physical system as well. On the other hand, the links of physical vulnerability and socio-economic vulnerability refer to a connection through functional efficiency of exposed elements on socio-economic life (Figure 4). To clarify the links between socio-economic parameters and physical vulnerability, we will refer to systemic vulnerability components (mostly infrastructural systems) with their possible impacts on the socio-economic environment. With this knowledge we will focus on the deficits of socio-economic structures which lead to failures in the physical environment. In other words, in order to reveal the impacts of socio-economic factors on physical vulnerability a case-study based approach will be followed. The starting point will be the possible impact of infrastructural damages on the socio-economic assets of a given region. Subsequently attention is given to the inherent vulnerability of socio-economic systems that may enhance infrastructural vulnerability.

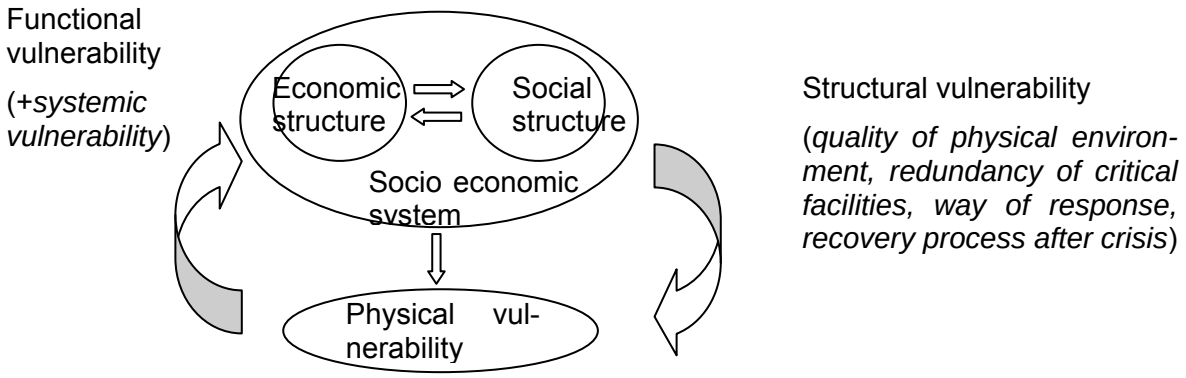


Figure 4: Relationship between Socio-Economic Vulnerability and Physical Vulnerability

The relations between socio-economic vulnerability and infrastructural vulnerability can be both direct and/or indirect. Considering the impacts of infrastructural vulnerabilities upon socio-economic vulnerability, they are not directly connected with infrastructural physical failures. However, the socio-economic environment may suffer because of the interruption of services which can be called functional failures. Here, infrastructural and socio-economic vulnerabilities are examined in two subcomponents each: (1) infrastructural system with (a) structural and (b) functional aspects and (2) socio-economic system at (a) individual and (b) community level (Figure 5). The reason of this categorization is that some social aspects at individual level (such as age, gender, ethnicity etc.) are not relevant with regard to infrastructural failures. However, when considering all these individuals as community, it would be easier to find out some effects of the socio-economic environment on the infrastructural system. As can be seen in the Figure, even though sub-components of groups are identified, the intersections in both Venn diagrams illustrate that no strict distinction can be made. For instance, due to a natural event, an infrastructural system is damaged which affects the running capacity of the system. Moreover, in the socio-economic environment, individual welfare is strongly related to national economy and/or territorial capital.

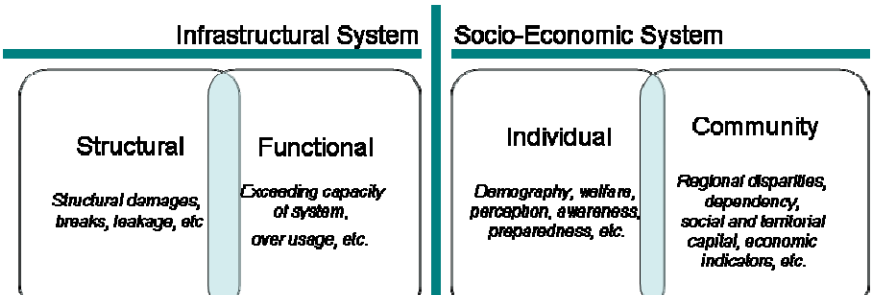


Figure 5: Components of Infrastructural and Socio-Economic Systems

3.1.2 Stage II: Implementation

The Northridge earthquake, of January 17, 1994, has been noted as the most costly disaster in U.S. history before hurricane Katrina hit New Orleans in 2005. The most remarkable impact of the earthquake was partial or entire collapses of highways which were major routes for daily commuting for manyeople. Fortunately redundancy of the transportation system in Los Angeles supported by several roads decreased the long-term impacts of transportation failures. Nevertheless, in the aftermath of the earthquake, several business units reported that both their employees had difficulties to reach their working places and they experienced difficulties in delivery of goods and services (Tierney, 1997). Except large scale collapses in certain parts of highways, the majority of reconstruction or rehabilitation of roads took no more than a few weeks (ASCE, 1995).

Similar transportation failures were experienced in Kobe earthquake exactly one year later ob January 17, 1995. The collapse of Hanshin Expressway caused severe interruptions in both the operation of rescue activities and the further evacuation. However, as the city of Kobe has developed on a line between the Rocco Mountains and the Pacific Ocean, the low redundancy in transportation caused long-term impacts on the affected region. Moreover, the connection between the main land, Port Island and Rocco Island was interrupted. It took 20 months to reconstruct Hanshin expressway, eight months for the Osaka Bay route and three months for the Shinkansen rapid train route (The City of Kobe, 2008). Reconstruction cost and monetary losses by interruption of traffic flows caused great deficits in Kobe and Hyogo's economies as well as Japanese economic growth. Sichuan (China) Earthquake on the 12th of May 2008 caused wide range of destruction. The rescue efforts were especially complicated by interrupted transportation flows due to structural damages, falling rocks or landslides.

When comparing Northridge and Kobe earthquakes, there are big differences in response and recovery processes after the events. To identify these differences it is crucial to understand linkages between physical and socio-economic vulnerability. After the Northridge earthquake, the recovery process of physical structure was quicker than it was in Kobe. As both cities are situated in developed and pioneering countries, this difference cannot be explained by economic power. First, the impact of Kobe earthquake was greater than the impact of Northridge earthquake. Second, it is likely that the different recovery processes depend on the different institutional systems of both countries. These three examples, and many others, are evidence of how infrastructural vulnerability, when considering accessibility, affects every level of socio-economic structure of communities.

Another crucial infrastructural system is the electricity network which is very important to business continuity one hand and public safety (i.e. traffic signals, street lights, safety alarms etc.) on the other hand. The Northridge earthquake hit business activities and production of high-tech industries in the Los Angeles Basin (Suarez-Villa and Walrod, 1999). In her case study Tierney (1997) found out that more than 50% of businesses were not able to continue to run their activities because of blackout. In another survey conducted by Tierney and Dahlhamer (1998), respondents declared that in

order to continue their business electricity is very important (82,1%) and without having this service they could operate their business with a median value of 0 (zero) hours.

Even though natural gas has a history for more than a century, the domestic usage has expanded only in the last decades of the 20th century. Today, natural gas is widely used in many countries for several purposes. The first major failure of a natural gas system occurred during Kobe earthquake in 1995. Since Osaka Gas Company was too late and slow in shutting down the valves, fires caused by ignition of natural gas from the breaks of pipes widened and caused further destruction and loss of lives in Kobe.

Communication systems changed not only personal habits to communicate but also the way to act during an emergency. In fact they play a key role during an earthquake and in the immediate aftermath. In the early 20th century, transferring information on what had happened in the disaster area, as illustrated by Messina (1908) and Avezzano (1915) earthquakes, was difficult, also because of the condition of communication networks. Nowadays, communication networks are more sophisticated and they permit to transfer information on the severity of damage related to disasters. But even if the standards of the communication systems were to be further improved, they are not immune to damages. As described by Chang and Nojima (1998) for the Kobe earthquake, the breaking down of electric lines caused the failure of the Satellite Communication Network, installed at the Prefecture of Hyogo, civil protection organization for the city of Kobe. In the Sichuan earthquake (China, 2008), the mountainous areas in northern Sichuan were completely isolated and the Chinese government had to send paratroopers to get information about the situation. Moreover, communication networks tend to be highly congested after an earthquake, both because of damage to facilities and high usage. In Italy, the solution adopted in case of local congestion, linked to several issues, is the call gaping. This means that the system assures that every call that exceeds the net capacity will be locked, and that the system will asks the customers to call again later. The system which has been used in California, enables priority access to telephone lines for critical facilities such as hospitals and firemen (Menoni, 2001). Such organizational mitigation measures can ease the future post-disaster management.

5.1.3 Stage III: Evaluation

Table 4 gives a general summary from past earthquakes on how physical failures affected and may affect socio-economic structure. Failures in infrastructures have direct impacts on human live and safety at individual level, and at a higher level the reconstruction process charges the national budget. After disastrous events, poorer countries may have to loan from other countries for recovery purposes. Depending on both, intensity and location of the event, collateral hazards (most evident for na-techs) may occur. As a chain reaction toxic materials are released into air, water and soil and indirectly affect human health and the quality of life in the medium or long term. Functional infrastructural failures, on the other hand, refer short and medium term after disasters. The most critical issue following disasters is to get accurate information about spatial distribution of damages in order to organize search and rescue activities. Thus, a working communication network and accessibility is vital in managing the situation. Business activities are mostly vulnerable to blackouts and transportation system failures that hinder production and impede the delivery of goods and equipment. When looking at previous natural disasters (i.e. Northridge earthquake, Kobe earthquake and Kocaeli earthquake), the economic losses in businesses caused by such failures are called 'indirect losses' which are not easy to estimate or to calculate because of the complex structure formed by linkages among business activities.

Blaikie *et al.* (1994) define the progression of vulnerability with certain indicators related to the socio-economic environment at community scale, as previously mentioned. In Table 5, relevant socio-economic indicators which are likely to affect infrastructural vulnerability are listed. Structural vulnerability depends on fiscal asset, awareness and willingness of the community. Even though a community has a good assessment of the situation, it may not be able to afford taking relevant measures.

Even if a community has fiscal power, there may be other priorities besides mitigation of hazards with long return periods.

At the individual scale, functional vulnerability of infrastructural systems turns out to be important. In several past earthquakes, communication and transportation lines were blocked because of overloading. As part of family disaster preparedness programs, specialists suggest people to use telephones only for emergencies and not to use their cars in order to avoid traffic congestion. For instance, after the Kocaeli earthquake, several people either drove through the area or made calls several times as they were not officially informed well about their relatives.

Socio-Economic / Infrastructure	Individual	Community
Structural	Low accessibility or no accessibility to services. Collateral hazards	Medium to long term economic impacts Reinstatement costs Ecological impacts Impacts on human health
Functional	Limited information and limited services Misleading operational services (e.i. power and rescue)	Decrease in administrative services Decrease in production and interruption of business activities Problems in delivering goods

Table 4: Effects of Infrastructural Failures on Socio-Economic Structure

Socio-Economic / Infrastructure	Individual	Community
Structural		Dedicate budget for preparedness and mitigation activities Willingness to pay Demand for redundancy in critical infrastructure before and after natural hazards Hazard population growth and increase of density Corruption Public awareness, risk perception, acceptable risks
Functional	Over usage and mis-usage critical lifelines following to disasters (e.i. telephone lines and traffic)	Insurance and substitute of infrastructural systems Rapid Population growth

Table 5: Effects of Socio-Economic Structure on Infrastructural System

Population growth and increasing population density in already built-up areas are important indicators to allocate resources. In many metropolitan cities in the world, the growth has been followed by agglomerations and cities expanded in an un-manageable way. In some cases, such as Turkey, the planning process lags behind the acceleration of urbanism. In many big cities regeneration and development plans are only partially applied. These kind of patchwork infrastructural investments are usually not analyzed in a systematic approach that would enable a better understanding of the entire framework. Nevertheless, planning is used as a tool for economic development of certain places and regions. During the decision process on this type of investments the efficiency and cost-benefit relations have a strong impact on the final decision. However, as experienced in Kocaeli earthquake, when choosing a location not only economic considerations should play a role but natural hazards should also be taken into account in order to avoid disasters. In line with what has been said above, a disaster prone area should be used as disincentive and/or discouragement to new development, both in normal period and in the aftermath (Pelling *et al.*, 2002). On the other hand, in less developed economies, decision makers may always prefer a disaster prone location to no location at all to further economic development. To clarify, as affirmed by Coburn (1995), hazards are known to have direct effects on land price and so they possibly change the character of urban areas in the long term. Information on hazards such as micro-zoning maps can decrease the land value and its attraction, so "an educated real estate market can make decisions that protect itself against hazards" (Coburn, 1995). Increasing population density, as well, has a crucial impact on the infrastructural

system by the means of carrying capacity of the system. In other words, systems running with over-capacity in 'peace' periods are more vulnerable during and after disasters.

Risk transfer and the insurance system are key components of risk management. From a structural perspective this system is not directly related with infrastructural vulnerability. However, in the context of functionality, insurance systems and substitutes of infrastructural systems play important roles for the continuity of business activities. Moreover, the insurance system could be a way to increase the quality of preventive structures by ensuring the implementation of and adherence to safety regulations. In the Memphis and Shelby case studies by Tierney and Dahlhamer (1998), it has been noted that larger businesses pay more attention to insurance and preparedness activities than small businesses do. Small businesses are more vulnerable because they have limited financial and personnel resources. On the other hand, ownership is a crucial indicator to understand human behaviours. Homeowners and business owners are "better prepared than renters because they see themselves as having more to lose in the event of a disaster" (Tierney and Dahlhamer, 1998).

The case studies and examples given to discuss impacts of natural disasters on infrastructural system and consequently on socio-economic structure of affected regions show that there are strong linkages between systems which can be called causal. In many events, socio-economic impacts and failure are evaluated as consequences of physical environmental deficits. However, when looking from another perspective, the physical environment is shaped according to a community's demand and its financial capacity. Decisions taken by city managers (elected by citizens) influence urban and regional conditions in a positive or negative way. This mutual relationship sometimes leaves scientific facts on natural hazards with long return periods aside (i.e. the probability of a natural hazard in the next 100 years). Considering short life expectancy in politics and little longer human life expectancy, it is obvious that lay people and scientists/professionals do not perceive phenomena in the same way. Therefore, reinforcement, rehabilitation or reconstruction of the physical environment is not on the agenda unless a massive shock occurs.

Corruption is strongly connected to the physical environment. It is mainly caused by a wide-ranging economy, which includes construction of national infrastructures and the construction of network systems for individual homes. In fact, corruption is found at every phase in construction projects: during planning and design, in the awarding of contracts, during the construction process, and during the operation and maintenance of projects after construction is finished (Escaleras *et al.*, 2007). As demonstrated by the Marmara earthquakes in Turkey, the problem was not due to a lacking understanding of seismically sensitive engineering or appropriate construction standards, but rather due to unscrupulous and often inappropriately trained contractors who ignored the country's building codes with the consent of government inspectors (Lewis, 2005; Bohlen, 1999; Kinzer, 1999). Jorge Diaz Padilla, president of the International Federation of Consulting Engineers (FIDIC), affirmed that most consulting firms are doing their best to define and implement anti-corruption policies. Such approaches tend to be piecemeal, however. What is missing is an integrity baseline that can connect and transform isolated acts of integrity assurance (Stansbury, 2005). In the case of Turkey, the collapse of several buildings that should have officially been built in accordance with the 1975 building code led to the examination of the inherent deficiency of the construction system. Additionally, building consultancy has been integrated in the construction process immediately after the earthquakes occurred in 1999.

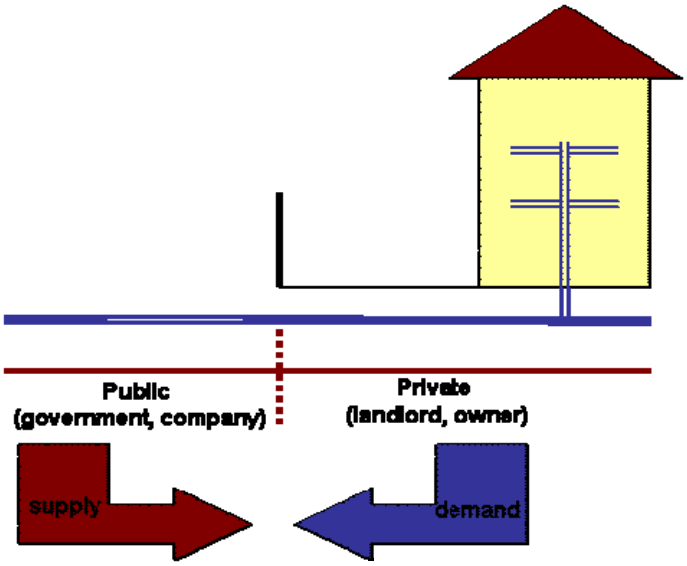
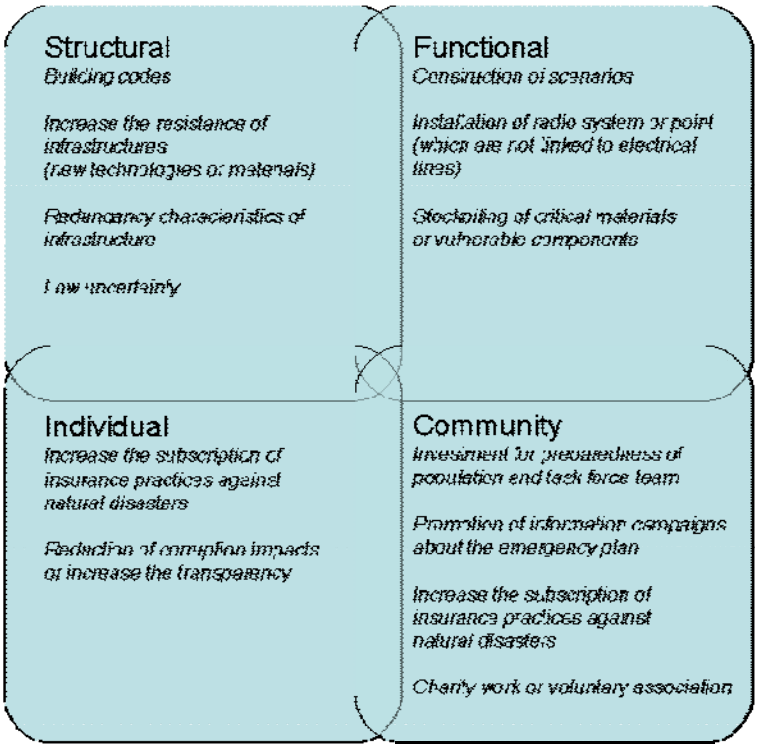


Figure 6: The Limits of Individual Interventions

Relations among Factors

As seen in Table 5, the cell of intersection on 'individual to structural' remains empty. Considering an infrastructural system which is a huge network covering settlements, an individual cannot have direct impacts on it. However, when these systems (or services) reach the end users, a modification by contractor, constructor or owner is always possible. In the Figure 6, the limits of individual interventions in the infrastructural system are shown as a sketch of a building plot. In this demand and supply circle, despite there are regulations on how to connect these services for domestic uses, after the first installation, the initiative belongs to users. In daily life, there are numerous examples for domestic and business accidents which are caused by poor maintenance and wrong modifications. Especially in developing and less developed countries, low qualified professionals, scarcity of financial resources and lack of awareness lead to insufficient safety standards.

To sum up then, it is worth to note once more that the physical environment is a product of the socio-economic environment. In the previous paragraphs, this relationship was described using recent case studies from different countries with different socio-economic levels. Defining vulnerability enables us on the one hand to get necessary measures for mitigation and on the other hand to define resilience parameters. In Figure 7, a brief evaluation on resilience regarding socio-economic structure is given. The sub-components of each box are strongly connected to each other in a network. From a structural perspective, resiliency depends on the implementation of building codes, redundancy and engineering approaches to improve new technologies and decrease uncertainties. Functional resilience is related to how people receive necessary services and the infrastructural organization supporting the system. Individuals on the other hand have their own responsibilities in reducing their risks in their business places and living places. Moreover, they can play an important role in improving the functioning of construction systems. Finally, the community is essential to increase resilience and to decrease vulnerability of settlements. Awareness, risk perception and acceptable risk level of each community depend on how much information they can get. Therefore, dissemination activities on disaster mitigation are very important to decrease socio-economic vulnerability that may have direct and/or indirect effects on other components of vulnerability.



5.2 Earthquakes, case of three Islands in Aegean Sea[4]

Taking an insular setting as a distinct risk environment, an effort is made to identify core issues relating physical vulnerability to social and economic features of such a context and to social and economic earthquake vulnerability. Three islands from the Aegean Archipelagos in Greece—Chios, Kos and Nissyros— serve as case study areas (Figure A.1 in Appendix II.A). Each island has a different profile as regards its administrative level, demographic composition, human geography, building stock and settlement structure, accessibility and transport conditions as well as emergency institutions (Table A.1 in Appendix II.A).

5.2.1 Stage I: Initiation

This contribution is based on previous research attempting to develop a methodology to pinpoint central issues related to earthquake risk and disaster protection policy, adjusted to the specificities of the insular setting (Delladetsima *et al.*, 2006).

Factors and Vulnerabilities

Based on the aforementioned research project an attempt was made to connect key social and economic features of the case study areas with physical and social vulnerability, both seen as susceptibility to loss and capacity to recover (Tables B.1 and B.2 in Appendix II.B).

The impact of these social and economic factors on earthquake vulnerability can be straight forward, but in many cases is indirect and depends also on a range of other factors as well as on the policies applied before and after the disaster. All in all, the possible impact of the social and economic factors on physical and social vulnerability can be disputed. It is case-specific, depending on context, time and territory. However, some relationships seem to hold more generally as demonstrated by previous experiences and related literature. These are put forward in the following section that summarizes the situation as presented in Table A.1 and Figure A.1 in Appendix II.A.

[4] Contribution by POLIMI

5.2.2 Stage II: Implementation

Aged population in an area is connected with less dynamism and less potential for change, lower building stock renewal rates and less building maintenance, thus higher physical vulnerability. What is more, older people are more vulnerable in case of an earthquake because of mobility difficulties and health fragility. Elder households are more reluctant to use financial support offered (loans, subsidy, and aid) in order to retrofit or repair/reinforce the damaged buildings, tend to stay longer to temporary housing and have less willingness to move on after the disaster. Based on lessons learnt from the 1995 Kozani-Grevena earthquake, pre- and post earthquake interventions to deal with physical vulnerability are more effective when they do not put the associated economic and managerial burden on the elder households (Mousteraki *et al.*, 2009).

Public Intervention

Acute income inequalities in the case study areas are connected mainly with on the one hand structural features of agriculture, low pensions for farmers as well as incoming legal and illegal migration and on the other hand fast economic growth through tourism. Low-income households spend less on seismic safety as they are forced to cope with everyday difficulties and tend to use (buy or rent) low market housing that can be older or of lower quality (possibly more vulnerable) or poorly located. Seismic retrofitting or repair/ reinforcement of earthquake damaged buildings normally results in an increase of housing prices and pushes low income households out of upgraded buildings and areas to old and vulnerable building stock. Research concerning temporary housing after earthquakes demonstrated that low-income households and renters tended to stay longer in temporary housing and that income loss because of the disaster affected their capacity to recover and rehabilitate permanent building stock (Dandoulaki, 1995).

Seasonal variation of the population associates with a temporal use of the building stock; this results in less exposure but also in less concern for seismic interventions and building maintenance. Population increase in the summer relates mainly, although not exclusively, to tourism. Tourism presses for more construction and it even guides development towards unsafe soil such as the seaside and steep slopes with a view. Tourism also leads to a reuse of old buildings stock, especially historic buildings and settlements. However, seismic safety is marginal in the institutional framework for tourism and a low priority for the tourist sector that is focused on promoting the positive sides of the place. As a rule, tourists have little awareness and low risk perception as regards earthquakes thus seismic safety is not marketable. All this affects physical vulnerability but the relationships are not straightforward and need to be examined case by case. Moreover, dependency on tourism makes the economy vulnerable in case of a disaster, or even in case of mere seismic activity, and can drastically limit the available means and resources for recovery. Such an activity raises the risk awareness of tourists and leads them to choose another holiday destination, possibly reducing the sector's income for several years.

The issue of vulnerability of historic buildings and settlements is a significant and multifold one. Interventions normally target upgrading the seismic safety of buildings according to the National Seismic Safety Code. Nonetheless the National Code does not always apply to the vast variety of local construction systems each posing a different set of problems as regards maintaining a balance between preservation and seismic upgrading (Dandoulaki and Delladetsima, 2003). To successfully intervene at the building level, policies must employ research, guidelines, codes, technical support, education and training, incentives and rising awareness in order to respond to the specificities of local construction systems. More challenging, still, is the task of putting policies dealing with physical vulnerability on the level of settlements into practice. This is so as it has to be done in a comprehensive manner, that takes preservation, seismic safety and development into account.

Building stock renewal rate seems a crucial factor for the selection of interventions to deal with physical vulnerability. While interventions targeting seismic safety of new buildings are well established, interventions on existing buildings are far more challenging posing technical, legal, economic,

psychological, social, urban planning, managerial and administrative difficulties. Table 6 depicts the spectrum of earthquake interventions for areas of high and low building stock renewal rate.

Uneven distribution of population and regional disparities are apparent on some islands. These associate with different rates of renewal of the building stock, uneven availability of means and resources for pre- and post-earthquake interventions, uneven distribution of infrastructure, facilities and services. In many cases physical vulnerability is high in areas of low exposure such as fading small settlements and low in areas of high population and building densities. This challenges decision-making as regards the geographical prioritization of interventions and the reconstruction strategy especially with remote and fading areas having little access to decision making.

Isolation of the islands and the accessibility conditions connect with the situation in the construction sector in terms of cost of materials and construction, regulation enforcement and know-how. Although it is difficult to identify a straightforward relationship between physical vulnerability and accessibility conditions, interventions should respond to these difficulties. For instance lower transport costs for construction materials may be required in order to promote seismic safety especially on small islands.

Connected to the isolation of islands are the administrative structure and decision-making procedures. Access to decision-making varies for each island depending on its administrative level. A key issue for some islands is that pre- and post-earthquake interventions to deal with physical vulnerability take place locally using mainly local potential and resources while decision-making takes places elsewhere and the competent authorities are based on another island.

Earthquakes

Interventions	**High renewal rate of building stock**	**Low renewal rate of building stock**
Physical structures		
Regulation		
Planning (land use, urban)		
Building codes		
Building permissions		
Building inspections		
Other regulation		
Standardization and quality control		
Insurance / Risk sharing		
Economic incentives		
Private initiatives (BCP, Corporate Social Responsibility etc.)		
Real estate, market and marketing		

Civil society initiatives		
Partnerships and networking		
Education, information & awareness		
Prevention and safety culture		
Emergency planning and management		
R and D		

Indispensable
Very important
Important
Useful
Irrelevant

Table 6: Interventions to Deal with Physical Seismic Vulnerability

5.2.3 Stage III: Evaluation

Key Factors

Summing up, the case study supports the idea that physical vulnerability is not primarily or even mainly a technical and engineering problem but that it is correlated with social and economic factors. Factors of social vulnerability, in the broader sense of the term, such as ageing population and income inequalities, have an impact on physical seismic vulnerability as well as on social seismic vulnerability each seen as susceptibility to loss and capacity to recover. Relationships between physical, social and economic vulnerability on the one and hazards and loss on the other side seem even more difficult to conceive. It should be stated though that the aforementioned relationships may be debatable if examined in another context and that generalizations can be misleading. Still, considering the social and economic profile of an area is of outmost importance, if one is to intervene successfully before or after a disaster.

5.3 Earthquakes, case of Abruzzo[5]

In the night of the 6th of April 2009, a 27 seconds earthquake occurred in Abruzzo region, in the central part of Italy. It caused the death of 298 people, the injury of 1600 people (La Repubblica, 6th May 2009) and the destruction of the historical centre of L'Aquila, the main city of the region, with some neighborhood completely destroyed (e.g. Onna center).

Straight after the earthquake, a comprehensible research for responsibilities arose. This was party due to the great number of victims that does not match well with the magnitude of the event, which was 5.8 on the Richter scale according to the AMRA centre. Such investigation was focussed on two main aspects, both related to intervention mechanisms:

[5] Contribution by T6

1. The need or, at least, the opportunity of alerting population, taking into account that significant earth shaking had been occurring in the area since the previous December;
2. The compliance of the building characteristics with seismic building codes.

5.3.1 Stage I: Initiation

An intense debate followed with respect to the first point. Once again, it has been remarked that it is not possible to predict earthquakes in the understanding of establishing exactly when, where and with which magnitude a given event will occur. At the same time, it has been confirmed that it is possible to make probabilistic forecasts.

In the area concerned, the seismic activity had been recorded for the previous five to six months. One day after the persistence of tremors and the last shake of magnitude 4.0 on the 30th of March, the Chief of the Department of Civil Protection[6] convoked a commission devoted to the analysis of major phenomena causing disasters (*Commissione Nazionale per la Prevenzione e Previsione dei Grandi Rischi*). During the meeting, the absence of a direct and unambigous relationship between the presence of seismic activity and the occurrence of an event of major severity has been highlighted. At the same time, such a possibility should have not been excluded due to the seismicity of the area and the existence of cases in which a shake with a magnitude of more than 5.5 (moderate intensity) was anticipated due to prior seismic activity (Commission minutes published by "L'Espresso").

Nevertheless, in the absence of a deterministic correlation between data, the Commission, responsible for awareness activities, decided to avoid any measure alerting the local population. On the following day, the Major of L'Aquila sent a telegram to the Department of Civil Protection, to the Region's governor, to the Prefecture and to the regional councilor of the Civil Protection, asking for the declaration of the 'emergency state[7]'. In detail, he asked for a proper and urgent expenditure for structural interventions as a consequence of the continuous shaking since January (La Repubblica, 18th April 2009). Even though this sounds as if serious actions were taken, the Civil Protection received no instructions from the Major.. Referring to an evacuation order, it is plausible that considerations about the socio-economic consequences following a false alarm have had the upper hand here.

In the light of what happened one week later, such decisions appear highly debatable. However, the huge socio-economic consequences caused by false alarms, as well as the negative effects false alarms have on the trust of the population in local authorities, are factors that should not be underestimated. With all the given uncertainties, an evacuation operation apparently was too expensive.

5.3.2 Stage II: Implementation

Apparently, at institutional level, something didn't work. The tendency to leave aside any possibility of the occurrence of the earthquake broadly prevailed and in some cases a sense of reassurance was spread. In this respect, a lodging house for students (*Casa dello Studente*) provides the most significant example. Located in the centre of L'Aquila city eight students died under rubble (Corriere della Sera, 15th April 2009). At this moment, no official sources reporting the declarations of the surviving students can be found. Chronicle news report that, following the 4.0 magnitude tremor of the 30th of March, many of the students, were worried about lesions in the structure provoked by the 400 shakes of the previous months. They thus requested the Technical Service of the building[8] to verify the safety conditions. The inspection took place and ended with a positive assessment as regards the

[6] In Italy the coordination of the National Service of Civil Protection is a competence of the Department of Civil Protection that is part of Presidency of Ministers Council.

[7] In this respect, it should be not disregarded the abuse of the "emergency state" requests by municipalities that induce to disguise those cases of real demand.

[8] The "Casa dello Studente" building was managed by ADSU, an entity for student's right but was a property of Abruzzo Region.

safety of the building. As a consequence, the students were reassured and invited to come back into the building.

The first controls of buildings have highlighted a widespread application of bad constructions practices. This topic opens a wider discussion involving legal aspects and building codes. The new Italian building codes have come in force only on the 30th of June 2009; hence, after the disaster. It is not an isolated case in that a disaster occurrence often provides the opportunity to review existing codes and plans (e.g. building codes in housing construction were enforced after the 1999 earthquake by the Turkish government; the approval of the Sarno decree 180/98 by the Italian Government after Sarno mudflows).

Anyway, in Appendix III, the last steps followed by the evolution of Italian building codes with respect to seismic risk are reported. The building codes should have been passed earlier but were delayed. This was due to the overlap of regulatory initiatives taken by two different entities (Civil Protection and the Ministry of Infrastructure) and to a lacking alignment with European measures (Eurocode 8). As shown, the approval and entering into force of seismic building codes has been subjected to an extension procedure since 2003 with an announced further extension to June 2010.

After the Abruzzo earthquake, this last extension comes into the fore as a shameful measure. Nevertheless, it is useful to highlight the reasons for this temporal shift since they shed light on some blind spots existing between socio-economic aspects that affect intervention mechanisms.

In the case at issue, the official declaration provided by the senator promoting such amendment has referred to the "requests of much time, by engineers and constructors, to comply with new rules" (La Repubblica, 10th April, 2009). Eminent representatives[9] of the first category refuse the explanation imputed to them: due to the long extension process, engineers have had enough time to get used to new codes. On the contrary, the influence on institutional decisions by the constructors' pressure appears a more reliable reason. In fact, a rise of prices to build (especially in terms of quantity and quality of used materials requested to satisfy security conditions) should have resulted in the application of the new building codes, according to a no saving economy criterion. This is an interesting demonstration of how 'hidden' socio-economic factors can influence, in a negative manner, some intervention mechanisms, in turn affecting physical vulnerability.

To sum up, the dynamics responsible for the delay in approval and force of NTC 2008 (Italian building codes) can be synthesized as shown in Figure 8.

[9] Interview to Eng. Martelli, responsible for the section Prevention natural Risks of ENEA (La Repubblica, 9th April, 2009)

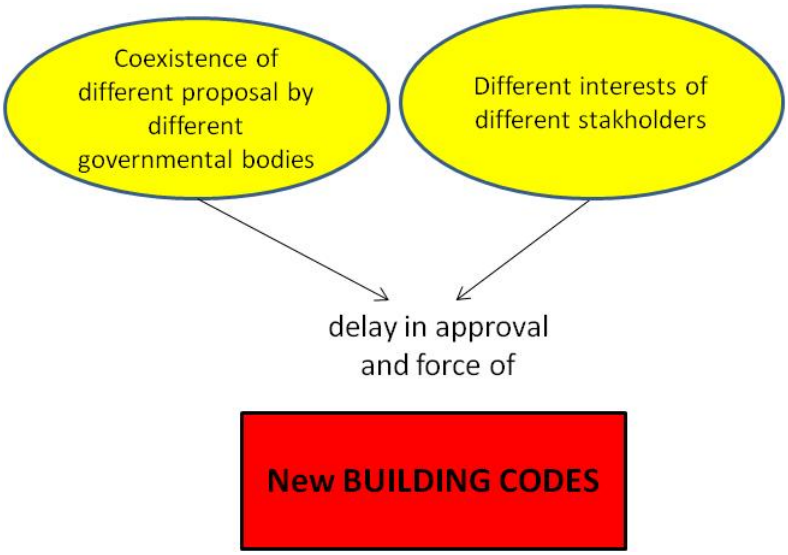


Figure 8: Main Factors Determining Delay in Approval and Coming into Force of New Italian Building Codes

Nevertheless, there is no doubt that a faster procedure of approval would have had not influence on the damage. In fact, the new building codes shall apply to the construction of new buildings and not to the existing built environment, which, as a consequence, is characterized by a major level of vulnerability in face of an earthquake[10]. Hence, other kinds of initiatives, in terms of retrofit and strengthening solutions, are required to deal with the different categories of buildings built in previous ages, including both masonry and reinforced concrete typologies due to deterioration and aging processes. Such initiatives fall into the category of prevention and mitigation measures, but their implementation is strongly influenced by cultural and economic factors. In the latter respect, the main deterrent is represented by the fact that such initiatives require a large amount of investment without immediate feedback. Nevertheless, with respect to the seismic hazard, the compliance of strategic structures with criteria recognized within the seismic culture, have to be warranted, especially in earthquake prone areas.

In this respect, the Abruzzo earthquake provides other topics of discussion. In fact, many public structures (the Court of law, the Cadastre, the Prison, the Regional Council, the University) have suffered severe structural damages and have partly collapsed. More alarming is the fact that during the emergency phase two structures have missed their strategic role. First, the main hospital of the city (San Salvatore hospital) had to be declared 'unfit for use' a few hours after the earthquake[11], and consequently needed to be evacuated. Second, the Prefecture (*Palazzo del Governo*), a symbol of L'Aquila city was completely destroyed, although it was restructured in the nineties (La Repubblica, 9th April, 2009).

While the strategic importance of a hospital in an emergency phase is rather obvious, the importance of the Prefecture is shortly explained. According to Law 225/92, the Prefect, at the occurrence of a natural disaster becomes the chief of the comprehensive management of the emergency services and has the responsibility of coordinating the emergency activities among the involved institutions (Province, Civil Protection, Municipalities) making use of the prefecture structure. That it was impossible in L'Aquila to follow up on this law can be seen in Figure 9.

[10] As an example, obsolete design principles include the use of plain round bar instead of deformed bars characterized by a better adherence with the concrete or the absence of stirrups inside the joint region in the columns.
[11] The hospital was inaugurated in 2000 and as a consequence, it was supposed to adequately react to an earthquake. Its evacuation has forced the Civil Protection to create a provisional medical service in the square in front of the San Salvatore structure and to move patients to other hospitals, even in other regions.

Figure 9: The Prefecture Structure of L'Aquila City after the Earthquake (source: Civil Protection)

Not surprisingly, the Public Prosecutor's Office (*Procura della Repubblica*) has opened an inquest to ascertain potential penal responsibilities related to the construction of buildings according to the Law 64/74, related to specific rules for building construction in seismic areas. The Public Work Office (*Genio Civile*), where documents related to the design of buildings and to construction companies are stored, has been seized for precautionary reasons in order to verify intentional responsibilities (Corriere della Sera, 18th April 2009). Presumably, the first inspections will be made on tenders for contracts won by the 'max *ribasso*' criterion, or in other words, the bigger discount on the initial amount requested to realize the work. Not rarely, such a discount has ranged between 20 and 40% with a clear subsequent difficulty by constructors to respect what the plans, in terms of specifications, established[12]. This fact gains further validity in case of tenders won through corruption practices. Public constructions are highly susceptible to collusion between levels of administration, elected officials, bureaucrats and private contractors with respect to other sectors (Bosher *et al.*, 2008). Anyway, the lacking compliance with the building quality turns into a lack of security, especially when facing an earthquake.

Such considerations extend the role of intervention mechanisms with respect to physical vulnerability. The 'max *ribasso*' criterion is a legal practice, admitted also in the last Italian Public Contracts code (D. Lgs 163/2006). The intrinsic risk is about accepting a saving at the cost of compliance with the plans, and as a consequence compliance with safety conditions.

Figure 10: Need of a Comparison between the "Theoretical" Specifications of Building Codes and Criteria for Awarding a Public Contract as Recognized by Law

Hence, even the procedures by which tenders are assigned have to be included among those intervention mechanisms affecting physical vulnerability. Obviously, it should be sufficient to realize controls and supervision during the period of construction and to pay particular attention to the stage of the final test. Taking an institutional perspective, it is worth mentioning another 'tool' abused by some governments. That is legalizing something that previously was not authorized, namely the building condone. Conversely, illegally constructed dwellings should be demolished both as warning

[12] As an example, the steel requested for the framework is paid according to the weight. To save money can mean to diminish number of elements, to reduce the diameter of bars or to advocate the expedient of variation within the progress of the work, at the expense of security conditions.

against such practices and for safety reasons. Not surprisingly, illegal buildings are built in risk-prone areas and any kind of inspections are avoided.

5.3.3 Stage III: Evaluation

To sum up, the Abruzzo earthquake is significant for the ENSURE project because it sheds light on some deficiencies with respect to intervention mechanisms that strongly affect physical vulnerability and provide suggestions to better understand the inter-linkages among different kinds of vulnerabilities. In detail, it has been highlighted how the socio-economic factors have influenced the approval and implementation of Italian building codes and how economic criteria can influence the construction of a building, apart from the quality of the drawings and its accordance with seismic codes. Hence, the existence of building codes particularly advanced in knowledge is a prerequisite for the spread of a seismic culture but it is not sufficient.

With respect to new buildings, further steps are matching the seismic codes with the wider contractual systems, avoiding subcontractor practices, condone and other tools (e.g. max *ribasso*) oriented towards saving at the expense of safety, and to implement a severe control systems during all the construction stages, that is from authorizations to final test.

With respect to the existing built environment, seismic retrofit and strengthening solutions have to be implemented, especially in earthquake prone areas. Delays in seismic adaptation have to be avoided, especially when it comes to strategic buildings (e.g. hospitals, structures of Civil Protection). A lack of these buildings would be a further source of vulnerability in a case of emergency..

Finally, in the Abruzzo earthquake, another intervention mechanism has that it lacks efficiency, namely the information and awareness system. Leaving aside the possibility of an evacuation due to the uncertain boundary conditions surrounding earthquake-forecasting, other preparedness-mechanisms have to be guaranteed,. In fact if 'false alarms' are dangerous, especially in terms of economic consequences, the spread of a sense of 'false safety' can be devastating.

It is worth reporting that at the time of writing this paper (end of June 2009); the Abruzzo region is still shaking.

5.4 The French West Indies case

5.4.1 Initiation

The French overseas territories located in the Western Indies, e.g. Guadeloupe and Martinique, are confronted to various natural hazards: moderate to strong earthquakes (e.g. Martinique, 1999, Les Saintes, 2004, Martinique, 2007), tropical storms and cyclones (Hugo, 1989; Marylin, 1995; Lenny, 1999; Jeanne, 2004), causing landslides and floods, and finally volcanic activity in Guadeloupe (last eruption of La Soufrière in 1976).

Among the past disasters that hit these territories, the earthquakes of Martinique (Mag. 5.4, June 1999; Mag. 7.4, November, 2007) and 'Les Saintes' (Mag. 6.3, November 2004) provide good cases to illustrate the influence social and economic factors as well as institutional mechanisms have on physical vulnerability. This is so as post-seismic investigations have been carried through and analysed so as to provide local and national authorities with seismic risk prevention and mitigation plans. In addition, the second crisis provides an example of possible interlinkages of different events. The Guadeloupe archipelago was first struck by intensive rainfalls, causing historic floods and numerous landslides on the main Guadeloupe Island (Basse-Tere, Grande-Terre), before the earthquake occurred between Les Saintes and La Dominique only a few days later.

Factors

From these surveys and the one also performed after the eruption of La Soufrière (1976), some main social and economic factors can be identified that may enhance the physical vulnerability in this region, in relation to unfavourable urban and land-use contexts.

An ancestral custom of mutual aid for individual construction (the so-called "*construction en coup de main*") is predominant in these departments: at the origin, it was developed in the colonial and post-slavery context, but it is perpetuated nowadays. It has even transformed into a generalized illegal work activity, performed by unskilled workers, who neither know about nor follow the basic anti-seismic design rules.

Two main reasons for illegal housing can be identified. First, there is a chronic lack of social housings, which results in an anarchic development of settlements (sometimes lasting for generations now), generally in dangerous zones (e.g. steep and/or unstable slopes, liquefiable zones). Most damages observed in Les Saintes Island and Basse-Terre (Guadeloupe) after the 2004 crisis, were caused by ground instabilities. Second, illegal immigration from the neighbouring countries (Haiti, Dominican Republic) is a crucial problem, especially in Guadeloupe. As a consequence, excessive concentration of precarious settlements is found in large urban areas.

Most buildings have been built either before the date of mandatory application of anti-seismic regulations (1998) or following now controversial design rules (only 27% is correctly designed in Guadeloupe). From the conclusions of the GEMITIS study performed by BRGM in 1999 (GEMITIS, 1999) a large number of buildings, including public buildings useful for crisis management (hospitals, fire stations, schools, etc.), would be destroyed in case of a strong earthquake. According to this report, an earthquake comparable to the 1839 or 1843 ones would possibly cause thousands of deaths, this time period corresponding to a probable return period for such a major event.
Furthermore, rescue infrastructures are often located in highly exposed areas (see Figure 11).

Figure 11: Fire Engines after the Les Saintes Earthquake

On a general level it can be observed that there is a high population density in highly exposed areas, with an average of 338 inhabitants per km^2 in Martinique and 248 inhabitants per km^2 in Guadeloupe.

On the local level surveys show that the risk perception and awareness of the local population and authorities is good regarding seasonal climatic events, as a consequence of their frequency of occurrence. The only problem may come from the unawareness of tourists (the only recent victim was an unwise tourist during Lenny in 1999). Hence, people are generally well prepared for such recurrent events (e.g. emergency kits kept in safe place in houses). Constructions also reflect this fact: in order to resist tropical storms and avoid consecutive effects, 'self-made' houses are preferably built on high grounds or on pilotis (out of reach of flooding), near slopes or cliffs (protection against strong winds), leading to higher physical vulnerability to earthquakes or landslides (see Figure 12).

Figure 12: Typical Housings in Guadeloupe

In contrast, seismic risk perception can be qualified as rather low, although the region has been struck by strong earthquakes in the past (e.g. Guadeloupe 1843: more than 3000 deaths, main city of Pointe-à-Pitre destroyed; Martinique 1839: at least 300 deaths, maybe around 3000 according to a reviewer, main city of Fort-de-France destroyed), and is still subject to regular tremors. The unawareness is partly due to the infrequency of occurrence of large seismic events, as evidenced by the surveys performed in Guadeloupe after the 2004 earthquake (e.g. CETE, 2005), which showed that a large public was not aware of being in a seismic zone. Respondents did not know what an aftershock was (about 25000 aftershocks occurred for one year after the main shock in November 2004) and thought that scientists knew the earthquake to be imminent.

The main pillars of the local economy are tourism and agriculture (e.g. agribusiness). For the Guadeloupe case, the last part of the road leading to the top of the Soufrière Volcano (located in the Guadeloupe National Park) is cut since 2004 and the main tourist parking is closed. Between 2002 and 2004 (before the crisis), the Region has also financed some large works to arrange and develop the tourist site of the second Carbet Waterfalls, but access is strictly forbidden since the 2004 earthquake, as it is classified as highly dangerous due to potential rockfalls and even cliff collapse. Lower incomes are found in these departments, compared to the other French continental ones, together with higher unemployment rates (around 22% for Martinique and Guadeloupe in 2008)

The communication and transportation networks (roads, etc.) are highly exposed to natural threats. For instance, in Guadeloupe, the only main road (RN1) between Pointe-à-Pitre and Basse-Terre, which is used daily by freight traffic, was totally cut for a few days after the 2004 intense rainfalls due to many landslides. Then, two tracks out of four have remained closed for six months after the November earthquake. Another small road exists in the North but it is difficult for trucks and takes much longer to reach the South end.

On the individual level, most people admit they are not prepared for earthquakes: 81% of investigated people had taken no specific dispositions before the Les Saintes event, and 85% admit having taken no new dispositions after it. Additionally, superstitions, mysticism (‘*It is a magical phenomenon*’), religious (‘*It is God’s will*’) and fatalist beliefs (‘*Nothing can be done against earthquakes’, ‘Part of the island will be engulfed’, ‘Earthquakes come with heat waves*’) are prevailing in the society, leading to passivity and wait-and-see attitudes.

There is also a predominant apology of self-resourcefulness, which may be a factor of resilience, but may also enhance physical vulnerability, as people do not understand the need to prepare. People either feel worried or suspicious about the official information: for instance, to the question “Do you think all the truth is said about the seismic threat?”, only 22% of people answered “Yes” (social study after the Martinique earthquake, 1999). This might be because the media or supports used to communicate on the subject are not adapted to the social context. The surveys have shown that messages are not understood, because people find them too abstract or general, and not pragmatic enough. Moreover, the general public by far prefers television as information medium to radio and newspapers.

A last influencing factor identified here is the role of the insurance sector. Half of the housing in Guadeloupe and only 1% in Terre-de-Haut and Les Saintes Island are insured. This is so due to an underestimation of potential consequences, insurance costs, suspicion and other priorities. Furthermore, Maaf insurance company broke many contracts after the Les Saintes crisis in 2004 and afterwards refused to take on new contracts arguing that the risk was too high.

5.4.2 Implementation

In Metropolitan France, the technical and legal acknowledgement of natural risks dates from 1982 with the allowance of financial compensations to victims from natural catastrophes, and from 1984 for the introduction of Risk Exposition Plans (called P.E.R in France) for various hazards (essentially earthquakes, landslides, floods). These Plans, established at municipality or intermunicipal scales, aimed at zoning areas exposed to predictable natural hazards. The Caribbean region, and more specifically Martinique and Guadeloupe departments, have been historically strongly exposed to various natural threats (seismic, cyclonic, volcanic, tsunami) and regarding seismic risks, both departments rank at the maximum risk level within the national classification (official decree in 1999); a level comparable to the one in Japan or California. Nevertheless, the French institutional recognition dates only from 1990, after the most destructive cyclone (Hugo) has struck Guadeloupe in November 1989.

Since 1995, P.E.R.s have been replaced by Risk Prevention Plans (called P.P.R. in France), with larger objectives: to ensure security for individuals, reduce if possible the physical vulnerability of exposed elements and reduce the costs of damages to the assets. The regulation is strict: new building is forbidden in zones classified with a high hazard level, if security of individuals is at stake. For existing buildings and properties located in dangerous areas, protection and safety measures can be made mandatory to private owners within five years at most. On the French West Indies, the first P.P.R. has been adopted in one municipality of Martinique (Prêcheur) only in 1999 (Leone, 2007).

In the framework of the International Decade for Prevention to Natural Catastrophes launched by the UNO (1990-1999), pilot studies have been initiated to assess the seismic physical vulnerability and to elaborate risk scenarios in the French West Indies (GEMITIS project in 1999). In addition, local strategies and initiatives for seismic risk prevention are implemented and tested since the Les Saintes crisis in 2004 in Martinique and Guadeloupe, within the framework of the National Seismic Plan (2005-2010) for the benefit of a large public (civil society, schools, workers, elected representatives, institutions, etc.). This shall reinforce or supplement the official efforts of the French State aiming at a greater implication of the local population and actors to their information and security concerning earthquakes (Mavoungo and Balandier, 2008). Within the National Seismic Plan framework, in 2006 Guadeloupe has launched a large program to assess the physical vulnerability of schools.

Moreover, an economic incentive is proposed by the Regional Council of Martinique since 2002 (it does not exist in Guadeloupe): an 'anti-seismic building prime' is given to private owners if they have their house built or controlled by specialists (architect, technical design or control office with required anti-seismic certifications). In 2006, this regional prime has been increased to 9000 € to cover most of the costs related to anti-seismic design/control, but it is still barely used, as conditions to obtain it are sometimes seen as too restrictive by some parts of the population (Mavoungo and Balandier, 2008).

5.4.3 Evaluation

The lack of regulation and control which has prevailed up to 1999 is greatly responsible for the anarchic development of housings in dangerous areas. Moreover, even when appropriate regulations exist, there is a general tendency among local representatives to be quite permissive essentially for electoral considerations. Another reason for this development is the crucial lack of building specialists adequately trained to anti-seismic design rules in Guadeloupe and Martinique, leading to design and execution mistakes (e.g. bad reinforcement, use of improper materials).

This can be explained by the fact that schools, universities and building professional courses of study are identical in these departments as in the Metropolitan ones, where there is no specific training on that matter. Martinique and Guadeloupe departments have recently begun to imply themselves in a true preventive dynamic, aiming at reducing the human and technical vulnerability to seismic risks: the 1999 earthquake in Martinique and later, the 2004 crisis in Guadeloupe can be considered as catalysers for this collective awareness. In 2000, thanks to the initiative of some local representatives, associations, architects and engineers, a specific class has been created in Martinique, followed by trainings for various building workers categories. In Guadeloupe, development of such trainings has begun only in 2006.

In fact, although institutional efforts have started for a few decades now and amplified since the recent crises (essentially Les Saintes, 2004), resulting in the launching of a National Seismic Plan in 2005 (to end in 2010) by the French Ministry of Ecology, success is not as expected, due to a number of factors which appear in the post-seismic surveys (e.g. see Cartier and Colbeau-Justin, 2007; de Vanssay, 2007).

However, it can be said that in general the indirect aims are achieved: to make people aware and incite designers to follow the necessary trainings. Another unforeseen positive consequence of this policy is that the Regional Council is considered as a good resource partner for people willing to prepare to a catastrophic event or prevent it: medical workers, district associations, schools or any citizen come there to get technical or legal information, etc. Moreover, projects for cooperation with other Caribbean countries are under way to transfer competences of the specialists from Martinique.

Finally, regarding information dissemination and awareness mechanisms, the objectives and means of communication towards aware/unaware audiences have been elaborated by the local state representatives (e.g. the Regional Direction of Environment) thanks to the outcomes of post-seismic surveys, in order to fit the local social features and concerns. The main initiatives consist in specific awareness campaigns lasting over a few days or a week, such as the 'Sismik' and 'Réplik' days or weeks organized annually in Guadeloupe and Martinique respectively (e.g. see Intermedia Dom Immeuble, 2008). On these occasions information on various media are provided, depending on the target public: slogans, recurrent TV spots/clips and radio spots (method successful for cyclones), debates, videos, posters (e.g. on bus shelters), games (TV, board), memo-cards, magnets, conferences, earthquake simulator, etc. A national emergency exercise (the RICHTER National Exercise, 2008), was also organized in Guadeloupe at the end of the 2008 'Sismik' week.

6. Floods

6.1 Floods, Case of the Netherlands[13]

In 1995, after 40 years of no major flooding, the provinces of Gelderland and Limburg (the Netherlands) had to deal with two flooding rivers, the Rhine and Meuse. The main characteristic of those floods was the smooth evacuation of 250.000 people. This case will show how this operation could run so smoothly and what the role of the decision-makers was. The case is an example of the policy cycle of our three stages. The Initiation stage of the 1995 Flood is actually the Evaluation Stage of the 1953 Flood.

6.1.1 Stage I: Initiation

After the large flooding in Zeeland in 1953, the emergency system had to be adapted. In 1953, there were no strong emergency plans available. Because of a hierarchy effect – officials turned to their hierarchal chief to take the decision – there was a lack of organised activities when the flood came. Due to the weather conditions, there was no communication possible between the different emer-

[13] Contribution by ITC

gency organisations and they were not prepared and trained. During the hazard, competence conflicts and coordination problems occurred (Koppenjan and Hagelstein, 1995).

Factors

In the 1953 flood there was a lack of awareness at decision-making level. Organisations were not prepared and trained properly. No one knew at what level decisions should be taken. Competences were not clear and communication was not possible during the hazard. The role of management proves to be highly important during a hazard. Management interventions can reduce average damage by a factor 3 to 16. The effect of management can even be stronger than the effect of climate change (Tol *et al.*, 2003).

In 1995, local decision-makers managed the emergency. Regional Coordination Centers worked fast and effective. They spread information concerning the emergency to the media. Also, emergency plans were available (Koppenjan and Hagelstein, 1995).

Vulnerabilities

In 1953, physical vulnerability was increased due to dike breaks, high level of groundwater, damaged houses and infrastructure. In 1995, heavy rainfall and melting water that raised water levels in the rivers Meuse and Rhine increased the physical vulnerability (NEDIES, id 167). In the future, vulnerability of protected areas will increase more due to population growth (social factor) and economic development (economic factor) (Klijn *et al.,* 2004).

In 1995, the social vulnerability was influenced by unpreparedness of people. The process of flooding did not occur for a long time before 1995; people were not prepared and built houses in river winter beddings, which are vulnerable areas (NEDIES, id 167).

Economic vulnerability was influenced by damaged economy and material losses in 1953. In 1995 the economic loss was high, mostly due to the evacuation costs like transportation and absence of economic activities during the evacuation.

6.1.2 Stage II: Implementation

Almost 250.000 people got evacuated from the flooding areas in 1995 in Gelderland. The success of the Dutch evacuation was a mix of good policy and good luck (Koppenjan and Hagelstein, 1995).

Public Intervention

During the 90s, Regional Coordination Teams were set up. On national level, a National Water Board ('Rijkswaterstaat') was established. New regulations of The Hague on flood management, spatial planning and nature conservation came into practice. New initiatives came also from Brussels, on international flood management, water management and nature conservation (Tol *et al.,* 2003).

In the beginning of the nineties, the perspective on water management changed. The process of democratization took place; more stakeholders got involved. Water management was no longer only focused on the defence against the water; the focus was shifted towards "living" with water (Tol *et al.,* 2003). The Delta Plan for Large Rivers: "*a policy aimed at minimizing the potential damage, raising public awareness, improving international early-warning systems, and developing measures to increase flood safety levels, preferably in an international context*" was formulated (Van Stokkom *et al.,* 2005). The concept of living with water led to the creation of emergency flooding areas. When a flooding of a river was expected, the Dutch drained the water off to special flooding areas.

Policy shifted from the separation of land and water, towards a policy of accepting water inflow. Climate change increases the likelihood of floods and due to the increasing population and economic growth, the economic and social vulnerability to flood increases. In 2001, the Dutch government formed a new approach with the following guidelines: 1) Increase the awareness of citizens concerning the problems associated with water. The communication of the government on risks has to be improved, in order to get citizens involved in risk reduction. 2) The need for a Three-step-strategy.

The three steps are retaining, storing and draining, and are based on anticipation to water and allocating more space to water. 3) Project More Room for the River; more space for water storage is needed. 4) Spatial planning; legislation should prevent the presence of housing and buildings in the floodplains. 5) The new water management approaches require more coordination and distribution of knowledge and education. 6) Clear distribution of responsibilities; different institutions are responsible for safety; an administrative agreement should be made to help division and cooperation between these institutions. 7) Investments; more investments should be made in order to support the developments. 8) International cooperation; intensify the international cooperation on flood protection and regional water management systems (Van Stokkom *et al.,* 2005).

Private Intervention

Before and during the evacuation of Gelderland, the media played an important informing role. It was the main link between citizens and decision-makers. Through the media, citizens became aware of the emergency and the actions taken by the government.

Civil Society Intervention

Following the news in the media, citizens did not wait for the official signal to evacuate. People saw on television that the floods came closer and that neighbour villages evacuated. Self-awareness of citizens led to this spontaneous self-evacuation.

6.1.3 Stage III: Evaluation

Key factors

The key factor in this case is the self-awareness of decision-makers (creating the policy) and of citizens (self-evacuation). The Netherlands have learned the following after the Rhine evacuation: 1) only clear and uniform information can pursue people to see the necessity of an evacuation. Communication between media and regional coordination centers are therefore important. 2) Preparations are important; the local governments have an important role in this process. 3) Individuals are hard to pursue to leave their homes. Therefore it is most important that people see the necessity. Otherwise it takes more time and effort to get people willing to evacuate. 4) All people have to be evacuated, hereby it is important to underline security measures to avoid theft and vandalism. People will leave their homes more willingly if they know that it will still be guarded. 5) A large number of people will reach safety zones on their own or organize the evacuation themselves. 6) Handicapped people, people requiring help and children need the most support. 7) The return does not have to be specifically organized (ICBR, 2002).

The success of the 1995 evacuation operation was owed to six elements. First the preparation, a specific emergency plan was formulated in 1993. The planning process was even more important, organizations were aware of the hazard and the possibilities to fight it. Secondly, the presence of a clear and a realistic threat. Images of flooding in the south of the Netherlands and Germany were shown in the media. Third, the time factor, people had time to prepare themselves for an evacuation. The possibility of an evacuation was announced on forehand. Fourth, communication to the citizens was done in three phases. Phase 1 was to prepare the people for a possible evacuation. Phase 2 was an urgent request to evacuate before a given deadline. Phase 3 was an ultimatum. 75% of the people were already evacuated before phase 3. Fifth, the role of the media; the media was used to communicate from the authorities to the citizens. Especially local and regional media played an important role. Last, the independence of people. Not the estimated 25%, but only 5% used public transportation to evacuate. People moved to friends or family outside the risk zone and did not use the crisis centre (Bezuyen *et al.,* 1995).

Blind spots

After the 1995 floods, political discussions arose concerning technical measures, like strengthening and heightening dikes around the Rhine river and broaden and deepen the Meuse bedding. Again,

the importance of not allowing buildings in winter bedding areas was underlined (NEDIES, id 167). Another political discussion concerned the analysis of the decision-making during the hazard. It showed the need of (more) strategic thinking, political courage, individual sacrifice for the public good and the integration of land-use planning and water management (Tol *et al.*, 2003).

6.2 Case of Germany[14]

In this section a look is taken at the floods that hit middle-Europe in August 2002. While several regions in Germany as well as in the Czech Republic were involved, the region of Dresden will serve as example.

In mid-August heavy rainfalls, which were rare in terms of intensity, duration and spatial dimension, hit southeast Germany as well as the Czech Republic. As the soil mostly was already saturated due to earlier rainfalls, these heavy ones rapidly led to a flooding of several rivers, among which the Weißeritz and the Elbe were the most important ones for the Dresden region. Even though for each river individually the intensity of the floods was not too rare, the simultaneous occurrence among all rivers is what made this flood especially severe (return period >150 years).

6.2.1 Stage I: Initiation

Factors

As with all natural hazards, human activities are not the cause of the catastrophe but have severe impacts on the effects such an event may have. In the case of the Dresden region such activities having a negative influence on the region's coping capacity were only initiates a few years before the severe flood occurred. This was so as the last major flood took place in the 1940s and the flood experience of the population thus has faded. In a survey Kreibich and Thieken (2007) found out that among respondents the last flood was on average experienced 28 years ago. Due to the lacking risk awareness, flood adaptation measures were no main priority. When Germany was reunited, eastern-Germany experienced a major pressure towards economic development in order to catch up with 'the West'. To further these objectives, ecological concerns were disregarded. Industrial areas were constructed in the floodplains, riverbeds were only badly maintained and also human settlements were built in the floodplains and in the inundation channels of the city of Dresden (*cf.* Kreibich and Thieken, 2007). These human activities apparently reduced the flood discharge capacity in the municipal area of Dresden (Grünewald, 2003 as cited in DKKV, 2003).

Vulnerabilities

The main social factor identified in the literature is the one of lacking experience and thus lacking risk awareness (e.g. Kreibich and Thieken, 2007; Thieken *et al.*, 2007). This is influencing all three vulnerability types as outlined above. Social vulnerability is enhanced, as no precautionary measures are taken when knowledge about the possibilities of severe floods is missing. Physical and economic vulnerability is clearly increased through the establishment of buildings in the floodplains.

Another important factor influencing vulnerabilities is the matter of ownership. As Thieken *et al.* (2007: 1026) found out in the region of the Elbe tributaries, where also Dresden is situated, ownership "was important for flood-proofing of the building". As house owners think more about safety and the value of their property as compared to tenants, ownership apparently decreases vulnerability. A link back to awareness can be easily established here as house owners inform themselves about the area in which their house stands and thus are aware of the hazards to which it is subject.

[14] Contribution by ITC

6.2.2 Stage II: Implementation

Public Intervention

Land use planning mechanisms are important tools for limiting the vulnerabilities of designated areas. If a decision on the prohibition of building projects is taken in a given region, this prohibition is the most effective means of avoiding an increase of physical and economic vulnerabilities. In the case of Dresden, the local authority is in the key position concerning decisions on land utilization. The authority enjoys a great discretion in this regard, as nation-wide binding frameworks concerning flood protection are missing. Formally, there have been regulations in place in Saxony, according to which some of the destroyed buildings should have not been built in the first place. But as they exist, there is apparently enough leeway to maneuver around disliked provisions (*cf.* DKKV, 2003).

A further public instrument is the one of technical flood precautions through retention ponds, polders, dams etc. Generally, the existing technical flood protection mechanisms were fully available in Saxony. This means that 121 million m^3 of water could be detained in dams and retention ponds. Nonetheless, this capacity was not sufficient for the events of 2002, hinting again to the exceptional severity of the flood. But overall, the technical instruments contributed positively to the situation by ensuring drinking water provision and allowing for extra time before the peak water level was reached.

Money was made available quickly during the events of 2002. The federal government of Germany made 7,1 billion euro available through the emergency fund for reconstruction (*Sonderfond Aufbauhilfe*). And also the European level was involved in providing monetary aid. Through the structural and solidarity funds of the EU, further 444 million euro were available for a rapid recovery.

Private Intervention

According to the DKKV, private precautionary measures are comprised of building precaution, behavioral precaution and insurance-supported risk precaution (DKKV, 2003: 124).

In Germany private households and industry have the possibility to insure themselves against flood damage and other natural hazards in line with the so-called extended natural hazard insurance. Insurance coverage was indeed quite high in the Dresden area, compared to overall German coverage. This has foremost historical reasons as the GDR offered its citizens an insurance scheme which included flood damage, which was then also included in successor products. It is thus estimated that in Saxony and Saxony-Anhalt about 50% of the affected households were insured (DKKV, 2003).

A clear lack of behavioral precaution prior to the flood is identifiable. Inhabitants did not necessarily know whether their neighborhood will be flooded and if so, when. Due to this lack of information, people did not know how to respond to the situation. Furthermore a basic knowledge about how to behave in such emergency situations was lacking. This situation is again evidencing the lacking risk awareness of both the general public as well as the public authorities that would have been responsible for the dissemination of appropriate information.

The usage of precautionary measures in building adaptation is a purely voluntary undertaking. Once a building permit is granted, it is up to the owners to decide if and how to protect the building against floods. The DKKV survey showed that there was a rather low willingness of owners to adapt their property in any way to the possibility of flooding. Kreibich and Thieken (2007) state that only 13% of the households had taken building precautionary measures.

Civil Society Intervention

The 2002 floods were accompanied by huge solidarity through voluntary disaster operation and millions of donations. Relief organizations were able to collect 264 million euro in donations. Non-monetary help was not used to its full potential, as the organizations were logistically overstrained.

6.2.3 Stage III: Evaluation

Key Factors

In most of the studies on the impact of the 2002 flood in Dresden, risk awareness emerges as the key factor for other actions. This awareness is clearly dependent upon the experience of citizens with regard to natural hazards. And as a consequence of awareness, preparedness is hypothesized to rise. It can thus be stated, that a flood experience raises the risk awareness, raises the preparedness on public, private and civil societal level.

Before the 2002 flood, 65% of the inquired households in Dresden thought that private precautionary measures were effective. However, only a small minority of households did indeed take such measures, being an indicator of the low risk preparedness of the city. Preparedness did not only play an important role during the event, but also in the aftermath through enabling a fast recovery (Thieken *et al.*, 2007). So, Kreibich and Thieken (2007) conclude that "much damage can be avoided by the means of private precautionary measures", the effective usage of which depends on the risk awareness.

Blind Spots

A clear weakness during the 2002 floods was the dissemination of flood warnings. Thieken *et al.* (2007) found that in the Elbe tributaries 42% of their respondents received no flood warnings at all and were thus not able to react properly. Even if warnings were received, the lead-time was often rather short, precluding effective building protection. Furthermore, the warnings were concerned mostly with evacuation information instead of information about the flood (e.g. maximum water level, time-to-peak water level) or information about damage mitigation. As emergency measures are the more successful the more time and people are available to take action, earlier and more detailed information is called for.

Policy Changes

Already in September 2002 possible policy changes were negotiated on the federal level. The result was the 'Five-Point-Program for the improvement of preventive flood protection'. It aims at a better coordination of international, federal and *Länder* programs to reach the common aims of giving more room to the rivers, to establish decentralized flood control measures and to use the management tools offered by spatial planning in order to minimize vulnerabilities. Also the further development of rivers needs to be closely examined in order to ensure an ecologically friendly usage of rivers as transportation routes. Furthermore emergency actions need to be better coordinated and self-help mechanisms shall be improved through the dissemination of information brochures (Bundesregierung, 2006)

In 2005 the Flood Control Act entered into force, which implemented many of the points raised in the above-mentioned plan. The new law puts a clear focus on preventive measures and on the introduction of uniform requirements for all *Länder*. Floodplains and flood-prone areas shall be managed better through risk identification and clear-cut definition of such zones and the incorporation of the possibility that technical flood protection measures fail in this calculation. The law is still not fully implemented. In this regard, Petrow *et al.* (2006: 727) criticize that "there are no regulations to ensure the appropriate implementation of flood precautionary measures".

On the regional level, the *Land* Saxony adopted the Swiss flood hazard mapping scheme (Petrow *et al.*, 2006). According to this scheme, four zones and different severity scenarios are devised, making the publication of a flood hazard atlas for all major rivers in Saxony possible. Also *Länder* that were not directly affected by the floods in 2002 now intensified their programs concerning flood protection.

6.3 Cases of England and Malaysia[15]

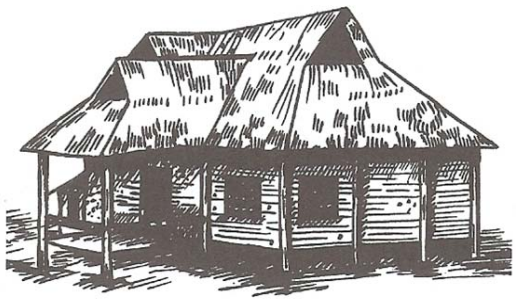
6.3.1 Stage I: Initiation

The loss of traditional flood adaptation knowledge causes an increase in physical vulnerability. Increased social vulnerability or increasing welfare culture dependence contribute to this development: cases from Peninsular Malaysia and London.

Vulnerabilities

Physical vulnerability of buildings to floods is likely to increase when knowledge about largely successful, traditional flood adaptations is lost. This may be either because of major, and usually rapid, social and economic transformation which weakens the social capital of communities, or because other factors lead to a progressive erosion and loss of construction know-how. This is a case of economic and social change impacting negatively on social ***vulnerability*** which in turn leads to increasing physical **vulnerability** to floods (see Figure 13).

Traditional Malay culture and rural ways of life are closely intertwined with the use of flood plains for padi planting, fishing and 'kampungs' (i.e. traditional Malay villages). The use of stilts to raise houses is a traditional characteristic of vernacular 'kampung' architecture and almost certainly evolved to allow people to inhabit swampy and unusually wet environments. Other adaptations, such as attuning padi varieties and planting to floods, are also used.



A 'Stilted' Kampung House, Peninsular Malaysia (from Parker, 2000)

However, with increasing urban-rural migration and the penetration of kampung life by Malaysia's rapidly modernizing consumer society, and with the Government's social restructuring policies, traditional architectural styles and flood adaptations are gradually being extinguished altering physical vulnerability. At the same time, rural-urban migration, which it is hoped by most migrants will lead to increasing financial resilience, has weakened the strong kinship ties present among kampung communities reducing their social resilience (and increasing social vulnerability) and contributing significantly to the breakdown of the process of inter-generational communication of local knowledge. State policies advocating low-cost terraced housing, institutional influences including housing legislation, and a tendency for the young to build houses without stilts, have combined to make stilt houses much less common particularly in western Peninsular Malaysia (Chan and Parker, 1996). Along with these changes has come increased physical vulnerability to floods, partly because houses are less resilient to floods (though they are more resilient to wind and torrential rainfall) and partly because urbanisation has increased both the magnitude and frequency of flooding. Similar traditional house design features, or finely-attuned designs, have been found in many part of the world including throughout South-East Asia, in The Netherlands, in Venice and in Bangladesh. Such construction techniques are now being 'rediscovered' by European policy-makers wishing to promote 'flood proofing' and 'flood resilience' measures in new building projects. Houses constructed on high pilings which raise them above river levels and tides, have also been found in other traditional cultures, including in the eighteenth century Cajun or Acadian settlements in the coastal swamps of Louisiana, USA (Laska and Wetmore, 2000), but are rarely used in modern constructions. Other traditional house designs, including coastal houses constructed with their gable ends facing the prevailing winds and tides (making them more robust) and with ground floor drains designed to allow the passage of floodwater beneath floors, also existed until recent redevelopment in Chiswell on the Isle of Portland on the south coast of England (Penning-Rowsell and Parker, 1987). In the northern Italian mountain villages researched by De Marchi *et al*. (2007), in which flash flood and debris floods are the principal hydro-geological risks, villagers are reported to have progressively lost their culture of self-protection over recent decades. They under-estimate flood risks, are unprepared for warnings and emergencies and no longer take precautions against floods. It is not clear whether any building adaptations for flooding have also fallen into disrepair, but in such circumstances they are likely to have done so. In this case, the relevant factors leading to vulnerability to floods (i.e. physical, social and economic

[15] Contribution by MDX

Increased physical vulnerability to floods is sometimes caused by formal urban growth and containment policies. This is a case of social and economic ***factors*** increasing physical vulnerability, to floods which in turn increase economic and social ***vulnerability*** to floods, as shown in Figure 14. Throughout much of the past century planners have advocated containment of urban sprawl through regulatory restrictions that include growth boundaries, green belts and limits to utility extensions. Containment is widely practiced in Europe and is a key component of 'smart growth' but it can have serious side-effects including increase exposure and physical vulnerability to natural hazards (Burby *et al.*, 2001). Development in the 'western corridor' along the Thames valley to the west of London towards Windsor and Reading has been constrained by tightly drawn green belt boundaries. The consequence has been that infill residential development of increasing densities has been the main means of accommodating rising household numbers. The density of development in floodplains which are not also green belt land increased greatly between 1950 and 1995 causing an increase in flood damage potential of more than 10-fold (Parker, 1995). This is despite comprehensive land use planning controls being introduced in England in 1947, and despite a series of Government Circulars to planning authorities since that date which seek to avoid development on floodplains (the latest policy document being Policy Planning Statement 25 discussed below). Some of this development has been adapted to flood risk, but even so physical vulnerability has increased dramatically.

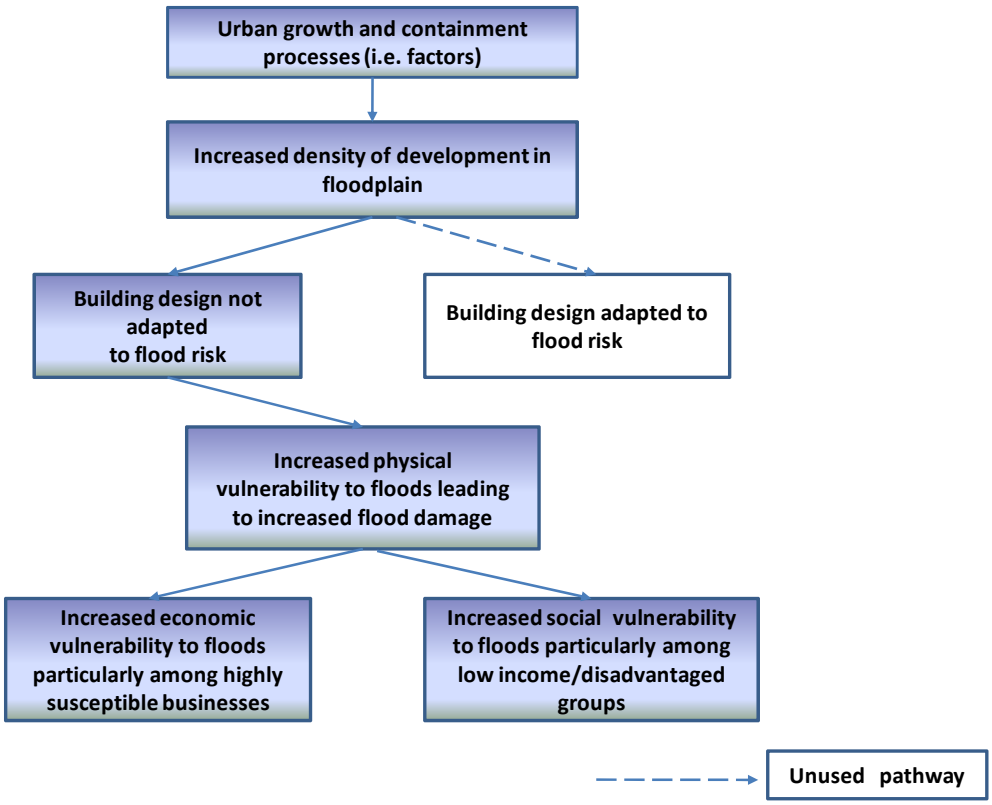


Figure 14: Relations Between 1) Physical Vulnerability and 2) Economic and Social Vulnerability of Floods Produced by Urban Growth and Containment Policies (i.e. 'socio-economic factors') in which Building Designs are Unadapted to Flood Risk

The reasons for this are a) south-east England is very densely populated, b) there is little 'undesignated' (i.e. already protected) land available for development purposes, and c) in the past local planners have sometimes ignored the objections to development on floodplains made by flood risk man-

agement agencies. In some cases development in the floodplain has been allowed by planning inspectors on national interest grounds. Generally, planning controls appear to have slowed development on floodplains, but it has far from been prevented and the development of south-east England's floodplains appear to have been almost inexorable unless environmental designations and policies prevented it. On the whole this is a wealthy part of the UK, but economic and social vulnerability to floods is likely to select the poorest members of these communities (e.g. pensioners, low income families, recent migrants, single-parent families) and businesses which are particularly susceptible to direct and indirect flood loss (e.g. new starts, businesses on the margins of profitability, businesses with equipment which is particularly susceptible to water damage).

Social and economic regeneration strategies may also cause an increase in physical vulnerability to floods. This is a case of social and economic ***vulnerability*** leading to increased physical vulnerability to floods, and is well exemplified by the major regeneration developments occurring in east London and the Thames estuary to the east of London to the North Sea. The initial problem is one of social and economic vulnerability in general (i.e. to poverty, poor housing, unemployment etc. and not necessarily to floods). In contrast to west London, east London has always been characterized by low incomes, poverty, immigration to the UK, poor housing, employment insecurity and disadvantage. It has also witnessed major industrial decline and commercial restructuring. A major social and economic regeneration initiative designed to address these problems has been launched in the past decade. However, this initiative is leading to an increase in physical vulnerability to floods because construction associated with this regeneration is being forced into floodplains and has sometimes been poorly adapted to flood risk, as shown in Figure 15. Planning and regeneration policies and strategies have, until recently, been insufficiently adapted to flood risk, and even now with enhanced regulatory instruments, adapting new developments to flood risk presents a significant challenge. Partly because of climate change impacts on flood potential; partly because existing flood defences are deteriorating; and partly because of the existing and planned build-up of investment in these floodplains, an enhanced flood risk management strategy is now being proposed (Environment Agency, 2009).

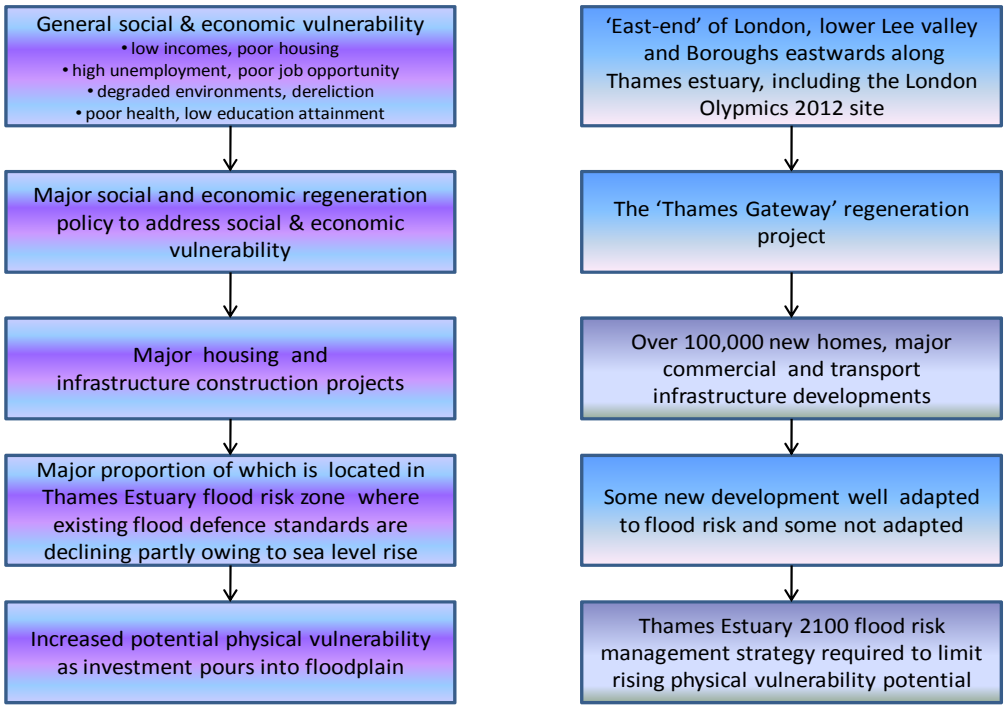


Figure 15: How Regeneration Strategies Designed to Address General Social and Economic Vulnerability can lead to Increase Potential Physical Vulnerability to Floods which Subsequently Requires an Enhanced Flood Risk Management Strategy: the Case of East London and the Thames Estuary

6.3.2 Stage II: Implementation

Public Intervention

England has well-developed, but not yet entirely effective, intervention mechanisms for addressing physical or structural vulnerability to floods (Table 7). These mechanisms not only address individual physical structures such as houses, but also infrastructure, development location choices and physical development layouts. They also address sustainable urban drainage systems. These intervention mechanisms have evolved over many years in response to experience (i.e. through periodic review of experience and performance; through changing flood risk management policy paradigms; and through efforts to improve the effectiveness of the mechanisms), thereby changing socio-economic circumstances and European legislative requirements. Since the mid-1990s, England experienced a heightened level of flooding activity and, particularly since the 2000 floods, there has been a much greater focus on refining and improving these mechanisms. Like many of its European partners, England's flood management policies shifted significantly during the first part of the current decade away from a structural (i.e. large-scale engineering), 'flood defence' emphasis. 'Making Space for Water' (Department for Environment, Food and Rural Affairs (Defra), 2005) introduced a 'flood risk management' approach which gives much greater emphasis to non-structural measures (incorporating small-scale structural adaptations) alongside large-scale structural measures. This approach has brought structural adaptations to the forefront of policy interest, experiment and innovation but much remains to be done before such innovations will have a significant impact in reducing England's rapidly rising flood damage potential.

Some intervention details for England and Wales:

Physical structures	There are now hundreds of 'flood products' on the market in the UK designed to help property-owners make their properties (most commonly houses) more resilient to flooding. They include floodgates, flood skirts, sump pumps, airbrick covers and so on. Government, the construction industry and the insurance industry, as well as the Environment Agency, also provide advice and recommendations on building new structures in a flood resilient way (i.e. using resilient designs, materials and fittings). Building regulations help with this although they are not yet adjusted to include flood resilience measures.
Land use planning	There is now an elaborate spatial planning system with specific requirements relating to avoiding and mitigating physical vulnerability to flooding.
Building codes	There is a voluntary code (Code for Sustainable Homes) which includes some guidance on flood resilient building standards. There are also Building Regulations, but as yet these do not include flood resilience regulations (this will probably change in the near future). There are however elaborate codes and regulations regarding installing sustainable urban drainage systems (SUDS) and the draft Water and Floods Bill (currently being considered) includes a tightening up on developer's and individual's responsibilities to create paved surfaces. There is an elaborate system of 'building control and inspection' and all new builds require inspection and signing off by planning inspectors at various stages.
Building permission	Almost all buildings and building extensions in England and Wales require 'planning consent' before development can go ahead. There is an elaborate system for planning proposals, planning applications, consents and appeals. 'Planning conditions' (e.g. about ground floor threshold heights) can be set when consents are given.
Other regulations	There are a wide variety of other regulations, for example, about how close to a watercourse development can be positioned; how close to tidal flood defenses development can be positioned; about sewer and drain capacities (re: sewer and surface water flooding); about highway design and surface water runoff; about SUDS; about dam building and building construction near dams (re: dam break flood risk), and so on.

Economic incentives	Central government has recently introduced a grants scheme to incentivise installation of property-specific resilience measures. In Wales this has been done through existing legislation but is proving bureaucratic. In England it is being done through a grants pilot scheme in selected qualifying communities. However, a number of local government bodies, particularly in cities recently severely affected by flooding (e.g. Gloucester, Oxford) have also introduced their own grant schemes for this purpose which acts as incentives. There are also economic incentives implicitly built in to the planning consent system because if someone builds or extends a structure without planning consent, the law makes it possible for planning authorities to require the build to be taken down at the cost of the builder/property owner. Similar enforcement capabilities exist regarding illegal or non-consented connections to sewers and drains.
Information and awareness mechanisms	These are well developed in England and Wales and comprise a number of published guides on how to increase the flood resilience of properties and their contents. These guides are produced by the Environment Agency, the insurance industry, central government departments and by the construction industry. In 'at-risk' towns and villages, flood fairs are sometimes held to raise awareness of resilience methods, and the National Flood Forum (which is a pressure group comprising members from many local flood action committees and groups) is heavily engaged in awareness raising and information provision.
Response measures	Reponses to reduce the physical vulnerability of structures and developments include the use of demountable flood defenses and community-based contingent response measures linked to early warning. Recent experimentation with demountable flood defenses in the Severn valley communities is leading to their more widespread use in England and Wales. The scope for these and other community-based small-scale structural measures is being researched in the Lower Thames valley in west London, and proposals have been made to implement some of these plans. Emergency evacuation plans exist is many flood prone locations, especially in tidal flood risk zones. These involve removing property from floodplains as well as people.
Private institutions	Disaster continuity planning has become widespread in the private sector and focuses upon reducing flood risk among a range of threats. This is partly to do with reducing the physical vulnerability of structures and related systems. A number of large companies in flood prone areas have invested in measures to reduce the damageability of their properties. The flood insurance industry provides insurance cover for structures and their contents.
Civil society institutions	Among the social capital of floodplain communities, local flood action committees and groups; river groups; the National Flood Forum and a range of other organizations are involved in the process of reducing physical vulnerability to flooding. For example, there are numerous such organizations in the Thames tidal floodplain in London and the Thames estuary.

Table 7: Hazard Types and Interventions to Address Physical Vulnerability

In England institutional arrangements and mechanisms for regulating physical vulnerability to floods comprise an integrated system in which local arrangements and mechanisms are nested within strategic arrangements. At the core of the strategic decision-making process is the Statutory Development Plan which comprises Regional Spatial Strategies and Local Development Frameworks (Figure 16). Central government set out its detailed requirements for managing flood risk in Policy Planning Guidance (PPG) 25 in 2001 titled 'Development and Flood Risk', which was accompanied by a detailed 'Practice Guide Companion' to be treated as 'Living Draft' (i.e. it was to be constantly reviewed and improved in the light of feedback from practitioners) (Department for Communities and Local Government (DCLG), 2006b). This has since been replaced by Planning Policy Statement (PPS) 25 in 2006 and a new Practice Guide in 2008.

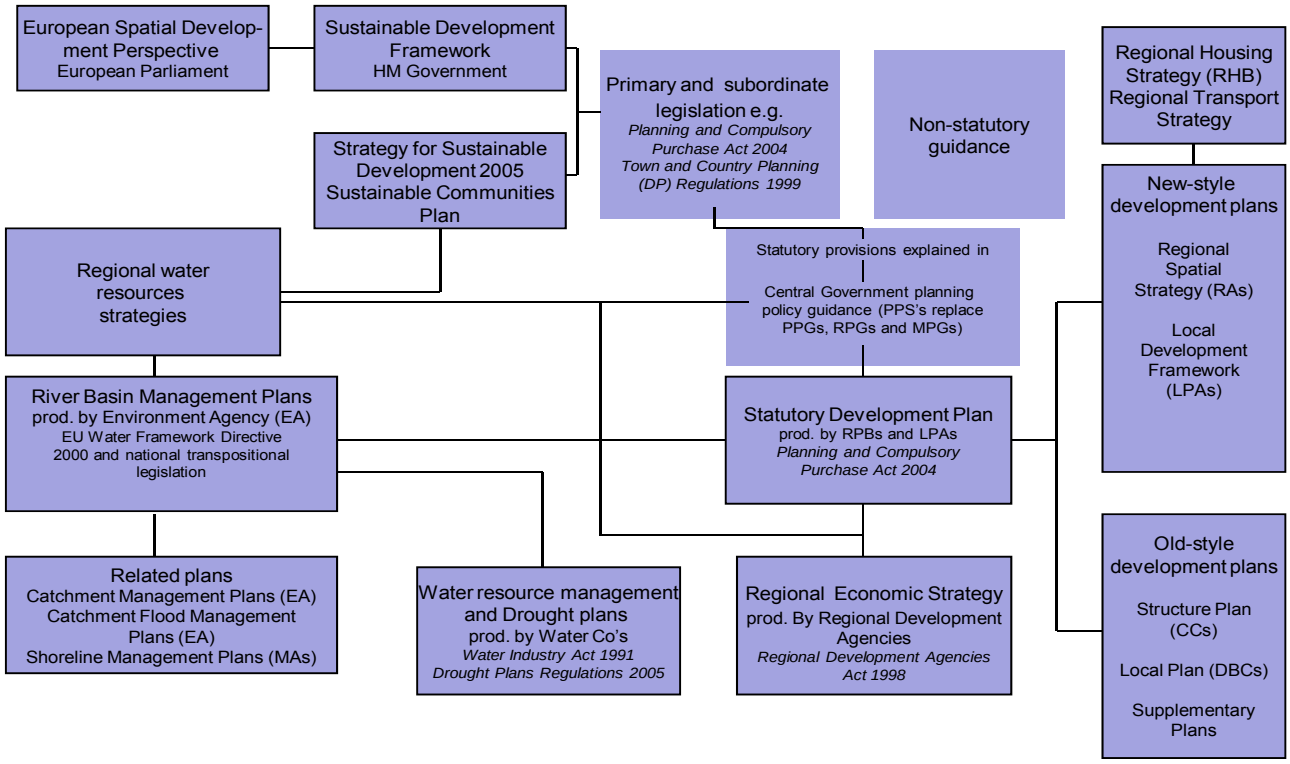


Figure 16: Strategic System for Urban Sustainable Development Planning Linking Land, Water and Related Planning Systems

Development proposals (e.g. to build or extend a house through to major residential or commercial developments, and in future major infrastructure developments) must be progressed through one of several planning processes, the principal one being shown in Figure 17. Planning applications must first undergo a thorough flood risk assessment which must be submitted as part of the application. Where a case is made for development in a flood risk zone, this risk assessment must demonstrate the ways in which development will be adapted to reduce physical vulnerability. Policy is that development in flood risk areas should be avoided unless there are no reasonable alternatives, and where development is proposed for flood risk areas mitigation and/or adaptation measures must be fully developed and implemented. In some parts of England (e.g. in London, parts of the Thames Estuary, in parts of West Yorkshire and so on), floodplains are already heavily-developed and very little alternative flood-free land is available. In such cases it is practically impossible to avoid development in flood risk areas. Where an application for development in a floodplain is approved the application is likely to be subject to conditions relating to floor threshold levels, sustainable urban drainage systems and flood adaptations. Under the Building Act of 1984 a comprehensive set of building regulations exists and is enforced through a process of progressive inspection undertaken at local level during the course of construction (Figure 18).

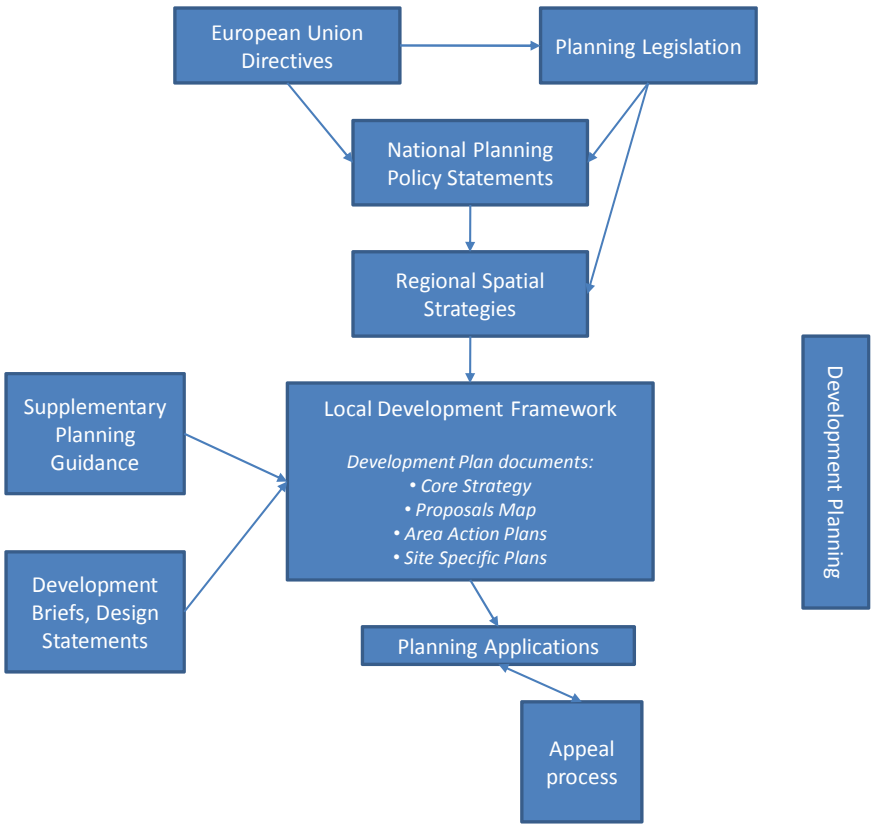


Figure 17: Components of the Planning Process in England

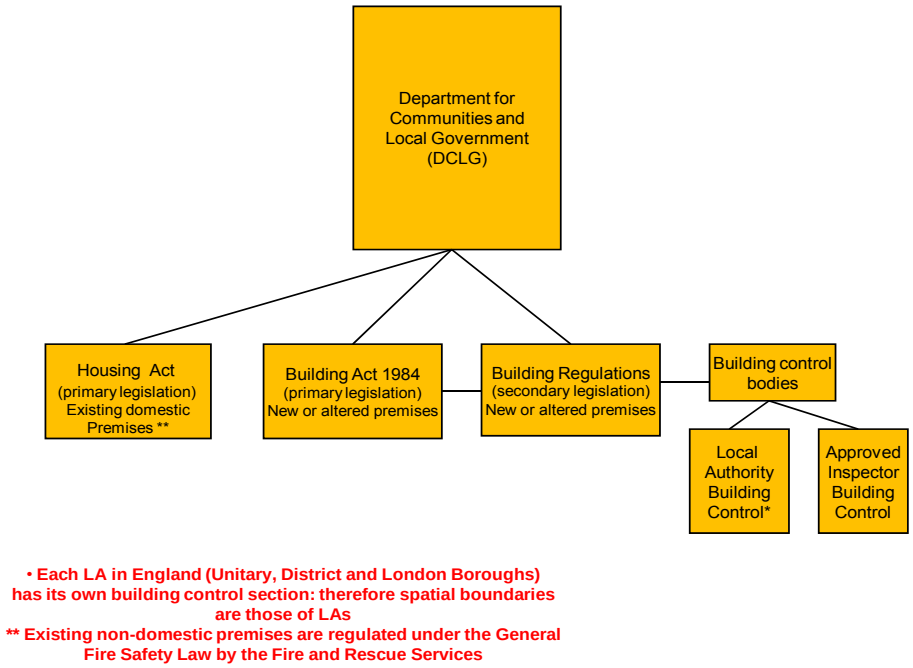


Figure 18: Institutional Arrangements for Building Control and Regulation in England

A weakness of the current arrangements is that the building regulations do not currently address flood proofing measures and flood adaptations although they do embrace other climate change adaptations. However, improvements are likely in the future as more scientific evidence becomes available about building adaptations and especially their economic effectiveness (i.e. their likely benefits compared with their costs under different flood risk conditions). A further weakness in institutional arrangements has recently been addressed by the introduction of House Information Packs (HIPs). Until recently, house vendors were not obliged to provide prospective purchasers with information on such aspects as the energy efficiency of the house or risks to which it may be subject, including flood risk. This has now changed, although a careful house purchaser could have always undertaken their own flood risk 'assessment' by consulting the Environment Agency's flood risk maps available on the web, and/or by commissioning their own environmental assessment (though apparently a minority did so).

There has been considerable interest in England in 'flood resistance and resilience measures' which are examples of 'control' and 'mitigation' measures which are applicable when 'avoidance/prevention' measures are infeasible and where development at risk requires protection. The approach is an adaptive one and incorporates both dry and wet proofing techniques for existing and new properties. The DCLG (2007) has set out a strategy for improving the flood performance of new buildings, and now recommends a series of flood resilient construction methods. Anticipated flood depths and floodwater velocities are important in determining the precise physical vulnerability reduction measures to be used. In the UK there are now over 400 kite-marked flood products on the market which tie into this adaptive approach, and the National Flood Forum (a national pressure group comprising numerous local resident's flood action groups) advocates their use, sometimes combining with the Environment Agency at local 'flood fairs' to provide information on them. Complementary construction guidance is provided by the Construction Industry Research and Information Association (2005) and in The Code for Sustainable Homes (DCLG, 2006b). Much of the recent research interest has

surrounded the costs and benefits of employing different portfolios of home flood adaptation techniques and the extent to which existing homeowners are likely to adopt such measures (Entec UK Ltd, 2007; Defra, 2008a,b).

The current institutional arrangements for encouraging and implementing flood resilient and resilience measures in England present a number of issues. Firstly, in England there is as yet no generally available financial incentive on offer from government to encourage homeowners to adopt adaptive measures to reduce physical vulnerability (though in Wales and Scotland there have been some such incentives), although home improvement grants are a potential vehicle for this. A number of pilot projects in several communities have, however, been funded by government, and following the 2007 floods in the city of Cheltenham, the local authority made small flood resilience grants available to homeowners to improve the flood resilience of their homes. Secondly, homeowners are in many cases unsure about the reaction of their private insurance companies to them investing in costly adaptive measures (i.e. whether this will ensure continuity of insurance coverage for example). However, through their trade association (The Association of British Insurers), the private insurance industry has been consistently stating that it will provide flood insurance cover for all properties which have a less than 1:75 year (1.3% probability) of flooding, and that for properties with a higher risk than this they wish to see evidence of either large-scale flood protection or effective adaptive measures. Thirdly, many homeowners appear unlikely to take-up adaptive measures even where they can be demonstrated to be cost-effective over a period. Take-up is affected by many social and economic factors, including anxiety, people's residential mobility plans, people's time horizon, competing problems and priorities, uncertainties, financial constraints, complacency and apathy, and worries about impacts on property values. In addition, there are significant circumstances in English floodplains where the frequency of flooding is unlikely to be sufficiently high to render adoption of adaptive measures financially attractive.

Institutional arrangements for flood relief and reconstruction are developed in a particular way in England. Until recently, the guiding principle has been to avoid the government compensating individual property-owners for flood damage because this subsidizes decisions to live in flood risk areas. However, severe flooding in Kingston-Upon-Hull in 2007 lead to central government emergency recovery funds being passed from local authority hands to some tenants and property owners breaching this principle. Central government came under pressure from the media which labeled Hull – a city with a poor and disadvantaged population – 'the forgotten city'. Most of the losses suffered were insurable and many received flood insurance payments (though some were uninsured). Two emergency flood funds are available for recovery and reconstruction purposes: the Bellwin Scheme which is a scheme for compensating local authorities' immediate flood response and recovery efforts, and the Flood Recovery Grant which support local recovery work. The latter was new in June 2007 and was used to help people in the greatest and most immediate need. Social funds were also drawn upon for those on benefit and on low incomes. A key underlying issue with the use of insurance payments and compensatory payments from government is that these funds are likely to be used to help reinstate properties that proved to be physically vulnerable and which may well be physically vulnerable again in the future. However, in the city of Doncaster which was badly affected by the summer 2007 floods, repairs to homes incorporated flood resilient principles so that these houses are better equipped to withstand floods in the future.

6.3.3 Stage III: Evaluation

Blind Spots

Few 'blind spots' now appear to exist in the arrangements for reducing physical vulnerability to flooding in England and Wales. This is partly owing to the higher intensity of flood activity in the past decade and the wide range of initiatives taken as a consequence. However, only a very small proportion of structures located in flood risk zones in England and Wales have either been constructed to flood resilient standards or have been retrofitted to such standards. It will take many years for such measures to become widespread. The summer 2007 floods revealed two particular blind spots that

have been researched since and are now beginning to be addressed (again it will take many years for this process to be implemented). The first blind spot is in the location of the nation's critical and significant infrastructure, particularly electricity sub-stations, large electricity generating stations, water treatment plants, sewage farms and similar installations. A surprisingly high proportion of these are located in valley bottoms and are prone to flooding at one level or another. Many are unprotected or not built to flood resilient standards. The second blind spot was the recognition and identification of areas at risk of surface water flooding from intense rainfall in urban areas, and where drainage capacity is inadequate to cope with the large volumes of water produced e.g. in Hull. Surface water flood risk maps are now being developed and the feasibility of developing a warning system is being investigated.

What can we learn about the socio-economic factors which increase physical vulnerability?

Table 7 lists the socio-economic factors which we believe influence (increase/ decrease) physical vulnerability to floods. As with any such list, there is a risk of over-simplification because there is a multitude of circumstances in which physical vulnerability to floods changes.

Factor	Increasing physical vulnerability	Decreasing physical vulnerability
Human ignorance of flood risks: their presence and physical and socio-economic processes which cause flooding	In general and in specific geographical areas an circumstances	Introduction of hazard processes into school curriculum
Progressive loss of indigenous knowledge of local flood problems and adaptations	Caused by breakdown in traditional life-styles and communities, rural-urban migration and family member dispersion	Early recognition of processes causing loss of knowledge and conscious strategies for it's retention
Lack of collective family or community memory of past floods	Caused by failure to store and pass on knowledge between generations; lack of community mechanisms for retaining information; fading interest; lack of understanding of the relevance of the past to the present and future	Build flood memorials; celebrate years without flooding; build flood museums; use in schooling etc.
Lack of a learning process within social institutions	Many possible causes, one of which is continued perception of floods as unconnected, one-off processes	Introduce learning organisations, institutions and processes. Undertake comprehensive post-flood inquiries/reviews, identify lessons to be learned, implement actions
Rapidity of urban growth and change	May outstrip the abilities of authorities to control development and to ensure resilience. Other priorities may be upper-most	Ensure robust spatial planning and development control institutions and mechanisms which lead to floodplains being largely avoided
Corruption and abuse of power relations	May have many consequences including ignoring downstream impacts and other externalities; sanctioning of illegal building development; sub-standard construction methods and so on	Anti-corruption measures and ethical practices
Rapidity of change in rural land use practices	May increase runoff and worsen flood regime. Many such practices e.g. certain forms of deforestation; increased upland drainage to lowlands	Comprehensive land use change planning system required to be in place and effective and based on a detailed understanding of catchment processes and plans
Uncertainties over	May be used as an excuse for moving	Adopt precautionary principle; invest in sci-

threats from physical environment	head with building development	entific evidence
Importing non flood resilient building designs and techniques from areas/regions with limited flood risk to areas/regions with significant flood risk	Very common world-wide and partly based on ignorance but also on inertia and the difficulty of experimenting with innovations rather than simply transferring 'tried and tested' methods	Begin with a strategic risk assessment, identify differences in levels and types of flood risk, adapt designs, materials and techniques to the new environments
Urban containment policies	The evidence is that although these policies prevent the undesirable coalescence of settlements and maintain green spaces, they may also lead to denser urban development and to encroachment into flood risk zones	Recognise the issue; ensure development that must be in flood risk zones is built to flood resilient standards; make a more conscious trade-off between needs and wants
Informal sector development in flood risk areas because the excluded have no alternative	Very common in third world settings e.g. in parts of South Africa, Asia and Latin America. Shanty town development is often 'pushed' into marginal land (i.e. land avoided for all other purposes)	Follow social justice policy agenda; adopt policies to include the excluded
Expansion of the historic cores of settlements from flood-free high ground into surrounding flood prone low land	Very common in Britain. Many towns and cities developed in this way including London	Urban redevelopment coupled with development retreat and resilience measures for existing settlements
Technological change and rising living standards	Many impacts which are negative in terms of increasing physical vulnerability. Rising values of assets at risk. Expansion of electrical and electronic products which are highly susceptible to water damage. Many other examples.	Many impacts which are positive in terms of reducing physical vulnerability. Development of flood resilient materials and construction designs; development of fibre optic cables which are resistant to water damage. Many other examples. Development of 'flood products'.
Regulation compliance failure	When building codes and regulations are avoided and compliance fails, perhaps owing to some form of institutional problem (or institutional vulnerability perhaps) then buildings can be constructed where they should not be, and standards may slip.	Monitoring of compliance and remedial actions to ensure strong compliance.

Table 8: Key Socio-Economic Factors Changing Physical Vulnerability to Floods

What can we learn about the relationships between physical vulnerability on the one hand, and social and economic vulnerability on the other?

The three cases at the beginning of this paper (i.e. loss of indigenous knowledge in Peninsular Malaysia; Regeneration in east London; Urban containment in west London) each inform about these inter-relations. In Malaysia, increasing social vulnerability appears to lead to increased physical vulnerability, but the increased social vulnerability is not just to flooding but also to almost any potential threat to the traditional kampung communities (e.g. to their continued existence, to life-styles, to well-being). It is worth noting that physical vulnerability can be very specific: in this case physical vulnerability to flooding is increased but physical vulnerability to the closely associated hazards of windstorm and torrential rain is decreased. It is almost as if the resilience to one hazard has been increased at the expense the resilience to anothers, but the process is unintentional in this case (it is simply a function of the qualities of modern building practice in Malaysia).

In the second case of urban containment in west London socio-economic factors appear to increase physical vulnerability which in turn leads to an increase in economic and social vulnerability which applies to the poorest members of society only. In the third case of socio-economic regeneration it is **general** socio-economic vulnerability (not socio-economic vulnerability to floods per se) which leads to policies being adopted which increase physical vulnerability to floods.

A commonality between the processes at work in these case examples, is that vulnerability (whether it is physical, social or economic) appears to increase in a largely unforeseen way – it is the consequence of decisions made concerning other priorities, or it is part of a 'run-away' process of change to do with modernization. However, with time these consequences are often identified, and it is then that policies are introduced to address these vulnerability consequences, if they are introduced at all. What we see, then, is that vulnerabilities change across the dimension of time and it may be many decades before the adverse consequences of an otherwise positive process of change and modernization are identified and addressed. And then it is often a process of 'catch-up' because already people and communities have suffered the adverse consequences of increased vulnerability. The hope is that future communities and their members will not be so badly affected in these places, but this flawed process of change and 'progress' appears to be deeply embedded in the larger process of human change. This makes it predictable and so we need to identify strategies based upon predictability to break this pattern.

7. Forest Fires[16]

7.1 Forest fires in Portugal and Mediterranean countries

Stage I: Initiation

Human-caused fires are the most important threat to forests and wooded area in the Mediterranean basin. The increasing living standards in Western Europe lead to a migration of population from the rural areas to the city centres. Urbanisation and the expansion of transportation routes have affected people's relationship to their environment with respect to fires (Costa *et al.*, 2007).

Reports of forest fires in France, Greece, Italy, Portugal and Spain show that in these areas more than 450.000 ha burned on average each year between 2000 and 2006. In 2007 the phenomenon got even worse, especially in the south-eastern countries; the total area burned was about 500.000 ha (Bassi *et al.*, 2008). Fires have caused extensive damage in recent years, leading to loss of human lives, affecting human health, burning properties, infrastructures and business, as well as causing extensive environmental damage in forest and agriculture areas.

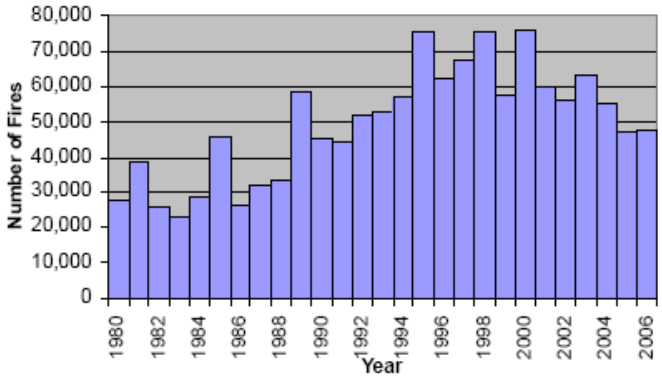


Figure 19: Number of Fires in the EU Southern Member States

[16] Case material provided by PIK, Germany

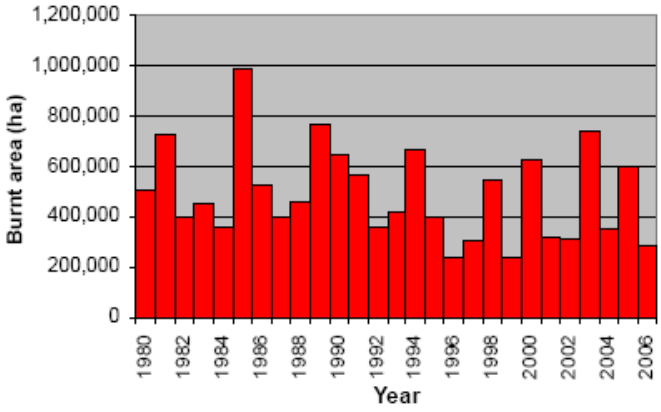


Figure 20: Area Burnt in the EU Southern Member States

Fire statistics vary considerably from one year to the next, indicating how much the burnt area depends on seasonal meteorological conditions. Despite this inter annual variability, it is possible to see that the number of fires in southern Europe increased consistently until the end of the 90ies and then slowly decreased until 2007 (Figure 19). Fire frequency followed an increasing trend during the 1990's, but since 2001 the number of fires has remained more or less stable. Regarding area burnt, no discernible signal of rise in area burnt numbers was noted (Figure 20). For the purpose of this task, the focus lies on two particular southern European countries that have been recently affected by extreme forest fires: Portugal and Greece.

Factors

One of the most important reasons for fire increase in Portugal is the change in land use. Agricultural land has been progressively abandoned since the mid 1950's, especially in the interior regions, leading to shrub encroachment. Increased labour costs have also made the cutting of shrubs for animal bedding uneconomical, hence eliminating one of the control factors (Pereira *et al.*, 2004). Abandonment leads to less occupation and tending of the landscape by people. Hence leaving new forests or shrublands unattended, and the landscape is decreasingly compartmentalized. All these factors create the conditions for the development of frequent and severe fire cycles, especially when large and continuous areas of shrubland are created (Pereira *et al.*, 2004). Furthermore, the abandonment of crop cultivation leads to conversion of extensive animal husbandry. In many interior regions, shepherds burn the area to maintain the ecosystem in the early succession stage of grassland. This has been an important factor for the increase in fire ignitions (Pereira *et al.*, 2004).

In Portugal, it has been observed that the majority of forest fires are initiated by intentional acts and negligence (DGRF (*Direcção Geral dos Recursos Florestais*), 2007). In Figure 21 it becomes visible how tightly connected the number of ignitions are with the population density and with the percentage of conifers in a forest (adapted from Costa *et al.*, 2007). On one hand, higher population density leads to a higher number of fires. On the other hand, a high population density is usually associated with a quick response of the fire fighters and therefore leads to a reduction of the spatial extent of an average fire.

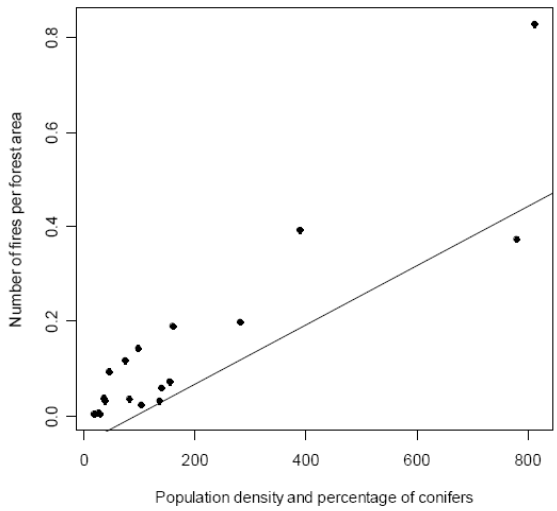


Figure 21: Relation between Number of Fires per Forest Area and Both Population

Costa *et al.* (2007) hypothesize that in districts with high population density the probability of an early detection is higher, leading to a quick response of the fire fighters and therefore to less forest area burnt. Data for the Portuguese mainland regarding average fire size and population density shows a tendency for a decrease in the average size of the fires as the population density gets higher (Figure 22). The time from the moment that a fire is detected to the moment that intervention by the fire fighters starts is crucial to the future extension and severity of a forest fire. A fast detection prevents fires from reaching a high areal extent (Costa *et al.*, 2007).

Economic changes in Western Europe have led to the migration of population from the countryside to the cities, to a slowing down of demographic growth, to abandonment of arable land and to disinterest in the forest as a resource (Alexandrian *et al.*, 1999). It is believed that the perverse economic incentive to clear forests for development has lead to an increase in the number of ignitions in Greece. Greek law prohibits development on land classified as forest, but because there is no forest or lands register it is nearly impossible to prove that burnt land was previously forest. Thus, arson is often suspected in the transition zones between forests and urban areas in order to allow profitable development. This aspect can also be traced to intervention mechanisms that did not support or promote adequately updated land ownership records.

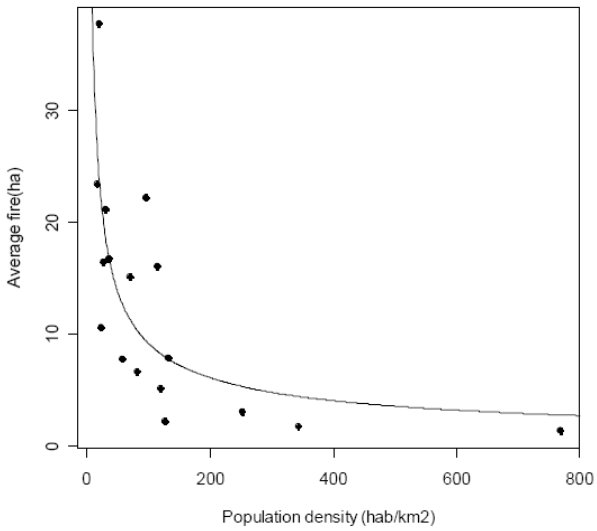


Figure 22: Relation between the Areal Extent of an Average Fire and Population Density in Each Portuguese District (Costa et al. 2007)

In general there is a lack of a traditional economic market for Mediterranean forest products, which discourages investment in forest management because of the lacking profit or financial incentives. In Greece, management of low elevation pine forests was supported by a Greek subsidy for resin, but this was discontinued in the 1980's when Greece joined the EU. Thus, a lack of incentives and the emergence of other financially more attractive opportunities led to low-elevation pine forests being left practically unmanaged. As these forests and villages were gradually abandoned, the number of forest fires and the area burned annually started growing steeply since the end of the 1970's (Xanthopoulos, 2004). Pine forests are especially vulnerable to fire and usually located close to the coastline, to urban centres and on islands. Such land is of high value and forests frequently become the target of arson, aiming at real estate development.

Stage II: Implementation

In southern Europe, the institutional structure of national forest agencies is context-driven and varies from country to country. In Greece, there are two agencies responsible for forest fires. Historically, the Greek Forest Service was responsible for all aspects of forest fires, but in 1998 the responsibility for fire suppression was transferred to the Greek Fire Service. The severity of the 2007 forest fires could be partially attributed to this division, which was compounded by the fact that funds for prevention have systematically been cut over time, rendering the forests more susceptible to fire.

In Portugal, national coordination used to be scattered, as forestry financial incentives used to be managed by the Ministry of Agriculture, while the Ministry for Internal Affairs managed the fire fighting. Following the extreme fire events of 2003, there has been a significant effort by the Portuguese government to reform forest management. They established a forest fund to implement forest management and fire prevention projects, and have focused on construction and improvement of firebreaks and water reservoirs. In addition, they have developed forestation programmes that aim to plant diverse broadleaf tree species rather than more vulnerable species such as maritime pine and eucalyptus, reducing the risk of forest fires and therefore the physical vulnerability of both populations and ecosystems. The effect of these policies will be seen in the long run. Unfortunately they have not been able to prevent the forest fire episodes of 2005.

Public Intervention

The recent developments in the use of prescribed fire were followed with a renewed interest in Portugal in the actual fight against wildfires. In 2006 DGRF created three to four groups of specialists analysing fire behaviour and having the capacity to assess the possibilities to use suppression fire as well as the skills to actually perform such operations. The Portuguese members in the groups had sufficient expertise in the operational use of prescribed fire during winter, and assistance from the GRAF (Forest Actions Support Group) in Catalonia and the *Plan Nacional de Manejo del Fuego* in Argentina was of great interest.

In summer 2006, these groups intervened in some of the major Portuguese wildfires. The success of the work encouraged the creation of six to seven groups of specialists in 2007. They received further training, and the continued assistance of the above-mentioned Catalonian and Argentinean organisations as well as the French organisation *Espaces Méditerranéens*. In 2007, these groups covered the whole country and were asked by the Civil Protection to assist in most of the large fires. Typically, when fires started during the night and aerial attack was not possible, the groups performed the analysis and the possible interventions with great success. These new initiatives, besides weather conditions, are thought to explain to a large extent the success of fire-fighting during the 2006 and 2007 seasons.

Recent Portuguese programmes tackling forest fires aim at the diversification of tree species composition. More broadleaf species shall be planted, as these are less vulnerable to fire than maritime pone and eucalyptus (Mendes *et al.*, 2004). This is thought to contribute to the reduction of forest fires in the long run. The major effects of these programmes are hardly visible in the short run, as it can take some time for the new species to grow. In addition, these programs are thought not to be able to solve the problem alone, and other problems may offset their effect. This is the case for instance of rural abandonment, with the corresponding abandonment of farming and the increase of scrublands in those places where forestation of abandoned land did not happen (Mendes *et al.*, 2004).

Private Intervention

Forestry-related programmes and funding in Portugal have generated a demand for technical advice by the non-industrial private forest owners. A growing number of forest owner associations were established since the 1990's, especially in the northern and central regions where small-scale forestry is more salient. The existence and sustainability of these associations is thought to be an important factor contributing to the effectiveness of forestry policy and to sustainable forest management (Mendes *et al.*, 2004). The World Wildlife Foundation, through its cork oak landscapes programme, is active in three priority landscapes (including Southern Portugal) to develop models for good practices in protection, management and restoration based on a multi-purpose management approach. This will aim at conserving all uses, values and services, deriving socio-economic benefit from all values, engaging communities, developing partnerships and promoting certification.

Stage III: Evaluation

Key Factors

After identifying social, economic and institutional factors contributing to physical vulnerability, a representation is made of how the factors are interconnected and related. Figure 23 shows a general representation of a forest fire chain sequence, from fire risk to the moment of fire extinction.

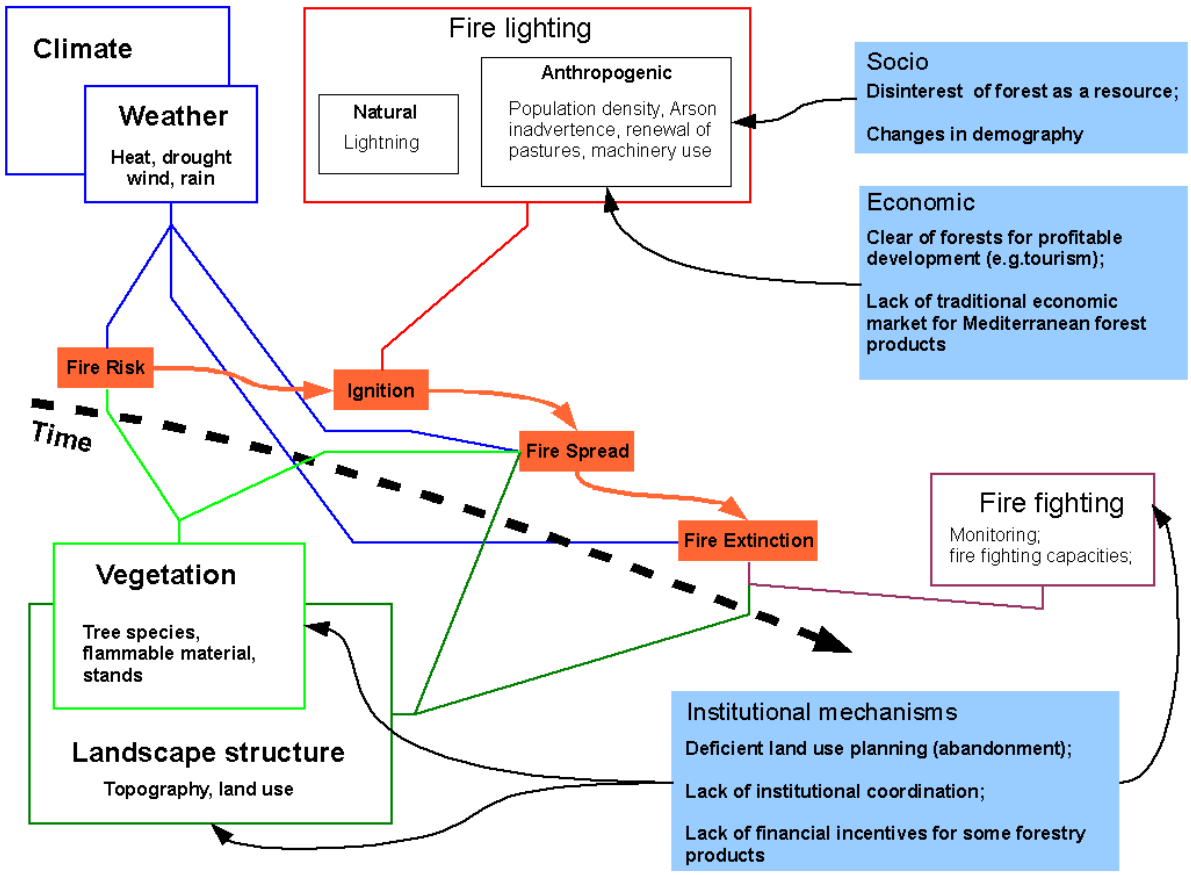


Figure 23: Chain sequence of a forest fire hazard and the key social, economic and institutional factors contributing to physical vulnerability

In blue some key social, economic and institutional factors contributing to physical, vulnerability are stated.

To sum up: a change in demography enhances the probability of fire ignitions (high population density) or the time required for fire detection (low population density). Lack of a traditional economic market for forest products can lead to the burning of forests for profitable development projects. Deficient land use planning and institutional coordination allows the enhancement of the fuel loads available to burn and sets drawbacks to fire fighting efficiency.

Blind Spots

Decisions on land use planning and prevention are always required. Investments in fire prevention mechanisms can be more effective than investment in fire fighting. Public awareness campaigns are essential due to the large prevalence of human induced fires in the southern European countries. In parallel, monitoring and early warning systems are also crucial.

The use of prescribed fire should be further considered since it is an effective tool for fire prevention by creating discontinuity in forests or burning shrubs and reducing the possibility of big forest fires spreading.

Political commitment is ultimately essential, especially with regard to the provision of adequate budget, the adoption of proactive rather than reactive responses, the amendment of conflicting policies and legislations and the definition of clear responsibilities for fire management.

Although the collection of data on forest fires is improving, it should be encouraged further, especially in light of a harmonization of terminology and definitions, and the development of a common format for regional databases on fire across countries.

Collaboration between countries, within and between regions (e.g. the Portuguese case in public interventions dealing with physical vulnerability) is generally increasing, and should be pursued further.

8. Landslides[17]

This chapter will provide an example of incorrect land use planning regarding the case of landslides in Italy. Incorrect land use planning leads to increasing natural vulnerability, resulting in more landslide phenomena and more private intervention. The case study relates to the Chianti region (Virginio river basin, Tuscany – Central Italy) were the realization of a new Chianti vineyard has produced a larger income to the land owners but also an increase of vulnerability, resulting in a larger number of landslides than before.

8.1 Chianti region (Virginio river basin, Tuscany – Central Italy)

Stage I: Initiation

Nowadays, the tight linkage between geological context and wine practices is widely recognized. Furthermore, this linkage should be taken into account by winegrowers during the phases of both production of the wine and management of the vineyards.

In fact, within comparable climatic conditions, on one side, the lithological characteristics and the geomorphological structure influence the pedological peculiarities (and, in turn, the quality of the vineyards in a given area). On the other side, planting a vineyard and the related practices induce important modifications in the geological, geomorphological and hydrogeological context in such a way that some slope instability phenomena can arise. Furthermore, the trigger of a landslide in an area devoted to wine production could directly affect the production of the involved area, as well as more seriously, the wine plant as a whole.

The present work starts with a general analysis of the link between land use and landslides phenomena in the Chianti region, more precisely in the Torrente Virginio basin situated in the Tuscania region (Italy). The aim is to highlight the influence of the presence of the vineyards on the susceptibility towards different typologies of landslides phenomena. The analysis takes into consideration both the natural and the anthropic factors.

Factors

The Torrente Virginio basin is the main tributary of Torrente Pisa and constitutes one of its secondary basins. The confluence of the two little rivers is located next to Ginestra Fiorentina, a municipality situated in the province of Florence.

The main waterway and its two most important tributaries, Rio Virginiolo and Borro of Baccaiano, are typical torrential rivers. Those are characterized by a significant reduction of flows in the summer period and by short time floods at the same time as intensive rainfalls during the autumn and the spring period.

Regarding the land use of the basin, 20% of the whole basin surface is devoted to vineyards.

[17] The case is provided by partner T6 Ecosystems, Italy.

Vulnerabilities

The starting point for examining the influence of the presence of vineyards on the susceptibility to landslides is the 'state of nature'. The state of nature consists of an analysis focused on the dimension and the location of the area potentially affected by a likely destructive event. The inventory of the landslides phenomena, together with maps reporting slopes and the emerging lithologies, have been used to realize such state of nature.

The inventory takes into account both the neoformation phenomena and the reactivated ones. This is so as this distinction appears to be fundamental for a correct assessment of the susceptibility, according to the adopted methodology.

The analysis has highlighted the following typologies of phenomena:

- Rotational slide of new formation;
- Falls of new formation;
- Reactivated rotational slides;
- Reactivated slow flows.

Another kind of flows, classifiable as mud flows, have been recognized even though such flows are secondary phenomena according to their number and to the reduced area involved.

Based on the lithological map, the deposits have been divided into four categories:

- Cobbles and gravel (Pcg);
- Gravel and sands (Pcg-S);
- Sands (Ps);
- Sands and Clays(Ps-Ag).

The slope map has been extrapolated by a DEM (Digital Elevation Model), in turn built by digitalizing the isohypses of the technical regional map at 1:5.000 and 1:10.000 scale.

This analysis has allowed the sketching of an evolutionary model of the area in which both the slope range and the lithological units are taken into account with respect to the different typologies of landslides phenomena. Such data have been synthesized in a table (Table 9).

Typology of phenomena	Slope range (°)	Lithological unit
Rotational slides and falls of new-formation	30-90	Pcg, Pcg-Ps, Ps
Reactivated rotational slides	15-30	Pcg-Ps, Ps, Ps-Ag
Slow flows	10-20	Ps, Ps-Ag

Table 9: Relationship between the Slope Range and the Lithological Unit for the Activation of a Particular Typology of Landslide Phenomena

According to Abbatista *et al.* (2005), the conditions that are shown in Table 9 are those responsible for determining the susceptibility of a given area to a particular landslide phenomenon. The assessment of the level of susceptibility is made depending on other factors that negatively affect the stability of the slope as well. Such factors can be considered 'predisposing' factors for triggering a given landslide event. Taking this perspective, the presence of the vineyard plays a central role for determining the level of susceptibility towards a particular type of landslide.

Stage II: Implementation

Public Intervention

Normally, agricultural practices are mainly dependent on the market and sometimes national and European incentives play a role. In this case, due to the high quality and economic value of Chianti wine private intervention prevails. The state is involved when allowing a change of land use.

Private Intervention

In the Chianti area, and more precisely in the Greve basin that is a Torrente Virginio adjacent area, the land use devoted to vineyards growing, represents 7,7%.

The landslide phenomena occur mainly in lithologies characterized by an arenaceous-pelitic complex structure, which is common in the area. It is represented essentially by quiescent slides and other secondary phenomena (equivalent to a 12% surface distribution), related to slow deformations (Figure 28).

It is worth underlining that 20% (208 events of a total of 1045) of instability phenomena recognized in the Chianti region occur in this basin that has 7% total surface devoted to vineyards growing. This observation confirms and supports the thesis that there is a great influence of the presence of the vineyards on the stability of the area with respect to the trigger of the events.

Stage III: Evaluation

To sum up, in the light of the study carried out in the Chianti area, and in detail in the Virginio basin, it is possible to state that many of the landslides phenomena involve areas in which some vineyards are planted.

Some examples of landslides, a slow flow and a rotational slide are shown in Figures 24 and 25, respectively.

Figure 25: Slow Slide on a Vineyard in the Chianti Region

Figure 24: Rotational Slide on a Vineyard in the Chianti Region

The roots of such behavior (Picarelli and Russo, 2004) can be found in the continuous modifications of the ground pressures regime. Modifications are due to the fluctuation of the internal pressures and

the erosion, across time, in the geotechnical parameters and the alterations of stresses. The role of the ground internal pressures is fundamental with respect to slides with a limited thickness. Creep, superficial pressures and other phenomena related to the alteration of superficial stresses are the main causes of other instability phenomena like deep deformations and lateral spread.

In this case, these effects are not linked to the land use typologies, but they essentially depend on the 'construction' and management typology of the vineyards. For example, a preliminary action for planting a vineyard consists of digging the ground for the extension of the vineyards by arranging the drainages needed for guaranteeing the adequate level of moisture to the plants. In this way, an artificial discontinuity surface arises, which is placed along the maximum slope direction and divides the cultivated ground from the bedrock. Furthermore, it is worth reporting that the bedrock is often constituted by pelitic rock that has a very low permeability. The characteristics of the displaced ground are, in terms of share resistance, not equivalent to the original ones when the natural cover was in 'in place'. Besides, due to the scarce geotechnical conditions of the replacing ground, especially where the slopes are not high, some phenomena as slow deformations (creep) can evolve into slow flows. In the light of this explanation, the model proposed by Picarelli and Russo (2004) can be correctly applied to this case study.

The above-described situation is further aggravated if the drainages are not adequately designed to sufficiently drain exceeding water. As a consequence, the cover surface can reach conditions of saturation and determine an increase of the local internal pressures.

9. Volcanoes[18]

This chapter will discuss a case description of volcanic hazards, according to the three stages Initiation, Implementation and Evaluation.

9.1 Kilauea volcano in Hawaii

Stage I: Initiation

Kilauea Volcano in Hawaii has been erupting nearly continuously from its lower, eastern flank since 1983. Prior to this, there were eruptions in the same general area in 1955, 1960 and 1977, but a long period of quiescence occurred between 1840 and 1955. Since the eruptions in the mid-20th Century, thousands of residential lots in the area were subdivided and made available for settling. The land, people and development are at risk from several primary volcanic hazards, including acidic airborne gases and aerosols, lava flows and minor ash fall, but also secondary hazards such as fire, earthquakes, ground subsidence, sea-level rise/flooding, storm surge and tsunamis. Each of these hazards poses different risks to the people living in the area, known as the Puna District. It is a relatively rural setting with a few small towns and villages, with a rich mix of social, cultural, environmental and economic characteristics. For example, the area has been the fastest growing district in the state of Hawaii for many years (primarily due to the availability of inexpensive, rural, isolated land, much of which is located within areas of high lava flow, gas/aerosol, and ashfall hazard), racial and ethnic diversity (i.e., there is a mixture of Asian, Pacific Islander, Hawaiian and Caucasians groups), lack of availability of some utilities (e.g., running water, electricity), and t

he scarcity of primary roads and employment opportunities. The growing population in Puna, combined with socio-economic factors, presents an interesting scenario with respect to physical vulnerability to volcanic hazards. Some examples of social and economic factors that influence physical vulnerability in Puna are discussed below. Unless stated otherwise, the discussion is limited to factors relating to lava flow hazards only.

[18] Partner University of Geneva, Switzerland provides the contribution.

Factors

Socio-demographic factors influence social vulnerability because of low income and education levels, lack of availability of running water and electricity in areas, and the heterogeneity of racial and ethnic groups, which make it more difficult to decrease vulnerability through educational initiatives. Moreover, social vulnerability is influenced by the limited number of roads that people could use to escape lava, when it poses a threat.

Economic vulnerability is influenced by a variety of factors which may increase or decrease vulnerability. For example, there is no large private or government employment base in Puna. There are few commercial businesses, some specialty agriculture and a geothermnal plant, but most employment is found several tens of kilometres away in the island's largest city, Hilo. The lack of a large employment base in the lower Puna District, where volcanic hazards are high, means that less is at risk. However, maintaining the ability of Puna residents to access their job places in Hilo requires protection of the one road connecting the residential areas of Puna to the employment base in Hilo. Considering that lava flows are a primary hazard in Puna, protecting this road connector (Highway 130) would be difficult in the event lava tries to cross it. The seriousness of this threat was made clear to people in Hawaii state-wide in 2008, when lava flows began advancing through remote forests and toward Highway 130. Fortunately, the eruption and its lava flows reverted back to the previous paths, for the time being sparing the highway and most residents of Puna.

Physical vulnerability to volcanic hazards in Puna principally centres on the susceptibility of residential homes, key infrastructure (e.g., roads, especially Highway 130; the geothermal plant; schools; and police and fires stations) and historic sites, parks and agriculturally productive land to inundation or isolation by lava flows. Besides, also corrosive volcanic gases also pose a serious threat. With respect to the threat of lava flows, however, there is little that can be done to protect land and structures, the exception being to construct lava diversion or retention barriers or artificial channels to either hold back lava from a given area or force lava around it. However, diverting lava onto land that might not otherwise be naturally affected has serious legal consequences and superimposed on these are moral, ethical, cultural, environmental, and political considerations that must be addressed before such engineered mitigation strategies would be used. Such barriers have been tried in Puna during Kilauea's eruptions in 1955 and 1960 and during an earlier eruption of nearby Mauna Loa volcano in 1881. Barriers constructed high on Mauna Loa's flank to protect a weather observatory have not yet been tested by an eruption. Other hazard mitigation options used in Hawaii have involved using aerial bombs and water. Aerial bombs were used on eruptions of Mauna Loa during eruptions in 1935 and 1942. Finally, water was used to cool lava during several Kilauea eruptions (e.g., 1955, 1960, and the current and on-going eruption). Private landowners built barriers constructed on Kilauea in 1955; in 1960 it was the government, so there are examples of public and private mitigation efforts.

The physical vulnerability of land and development to lava flows involves inundation and ignition by lava, in addition to isolation. For example, lava flows can crush, inundate and burn property. Property is not necessarily destroyed but may be rendered useless for considerable time when lava flows isolate a given area by severing roads. The typology of structures or type of lava flow (i.e., pahoehoe or a'a) may each determine the way in which structures such as homes are destroyed. Wood frame or wood exterior homes are the common typology in Hawaii. Such homes are more readily ignited than non-traditional block, stone or brick homes, and perhaps more likely to be ignited in advance of being crushed or inundated during a'a flows compared to pahoehoe flows. Which comes first, destruction by inundation or crushing from the force of lava versus burning by ignition from the heat of lava has been an important factor in determining the eligibility of structures to be covered by fire insurance. In terms of physical vulnerability to volcanic gases, volcanic emissions of sulfur dioxide gases create sulphuric acid which damages foliage on plants and corrodes metals. These and other gases also pose serious health concerns.

Stage II: Implementation

Public Intervention

Again, using Kilauea volcano in Hawaii as a case study, several institutional mechanisms available for consideration to reduce risk from volcanic hazards can be discussed. In an ideal world land-use planning would have been a powerful mitigation tool to limit the social and economic and physical vulnerability to lava flows in the lower Puna District of Kilauea. However, vast acreage of rural land was opened for development, presumably prior to understanding of the persistent threat that lava flows and gas and aerosols would pose to future development. Before land was subdivided and sold in the mid-20th century (1958), the last major eruption in the region had been in 1840, although one destructive eruption occurred just a few years before the subdivision in 1955. While there were later eruptions in 1960 and 1977, the practice of subdividing lava covered land of little to no other known significant economic value was already underway. It is the rapid subdivision of land that was approved which has caused the observed population growth and availability of lots to be built upon and settled. It is this settling on hazardous land that creates the social, economic and physical vulnerability tied to the area. To deal with this vulnerability, a variety of institutional mechanisms are available as mitigation options. Before discussing these, a point of clarification about land-use planning in Hawaii is necessary.

The example of County government approving hazardous land on Kilauea for residential subdividing does not go without saying that there are no good examples of wise land-use planning in the County. On the contrary, all one needs to do is examine the history of land-use planning along the shores of Hilo, where sound land-use planning policies have limited but not necessarily precluded development in some areas of high tsunami hazard since the deadly 1946 tsunami. Residential areas hit hard by the deadly 1946 and 1960 tsunamis were set aside for recreational use only, considerably limiting vulnerability and risk of people and property.

Back to the case study of institutional measures to mitigate volcanic hazards and their effects, especially lava flows. Apart from hardened or engineered strategies to mitigate lava flow hazards, other options include land-use planning to avoid or minimize development in hazardous areas, insurance, and simply bearing of losses. The lack of planning has already been discussed, but the role of residential insurance to protect against losses from lava flow hazards has not. Prior to the destruction of over 200 homes in the on-going eruption of Kilauea, known as the Puu Oo-Kupaianaha eruption, homeowners could insure their homes against damage from fire, even when the home was located in the highest hazard zones. But, with the loss of so many homes in the late 1980's and early 1990's, private insurers began declining homeowner coverage for homes in specific high hazard zones. Since this meant hundreds of potential homeowners would be without insurance, the Hawaii Legislature established the Hawaii Property Insurance Association (HPIA) in 1991 to provide insurance to homeowners, even those in the areas of highest lava flow hazard.

Private Intervention

There are many actions that can be taken by private individuals to reduce the physical vulnerability of property to volcanic hazards. During the eruption of Kilauea volcano, Hawaii, in 1955, local businessmen hastily constructed earthen barriers with bulldozers to hold back lava from specific land areas. While the barriers at Kilauea were overcome, they provided valuable insight for publicly constructed barriers built during a nearby eruption five years later in 1960. In terms of private interventions dealing with physical vulnerability of buildings to ash fall, individuals are advised to remove ash from rooftops and take precautionary measures to prevent ash from entering buildings. Similarly, they are advised to take actions that prevent the entry of ash into air intake systems associated with mechanical equipment such as automobiles and air conditioning systems.

Civil Society Intervention

In Hawaii, much land in areas of high lava flow hazard on the southern and southwestern flanks of Mauna Loa volcano have been recently purchased by the US National Park Service to add to the acreage of the Hawaii Volcanoes National Park, which covers portions of both Mauna Loa and Kilauea volcanoes, and by not-for-profit nature conservancies.

Stage III: Evaluation

Key Factors

Key social factors that influence physical vulnerability to lava flow hazards in Hawaii are factors such as race and ethnicity, culture, and income. These factors influence the 'culture' of living in areas of high lava flow hazard and beliefs about a) whether or not the hazard can be mitigated and b) whether or not the hazard *should* be mitigated. There are few options for mitigating lava flow hazards. The lack of sound land-use planning to avoid the hazard means that current and future populations are vulnerable. The finding that many people believe there is nothing that can be done to hold back or divert lava leaves the culturally sensitive political decision of planning for, let alone implementing, mitigation actions involving lava retention and diversion postponed until the verge of disaster. While the economic vulnerability to lava flow hazards in lower Puna District is low because of the limited commercial and industrial base there, the limited options for mitigating lava flows and the lack of open planning for mitigating lava flows with available means (barriers, etc) defines the physical vulnerability of all areas susceptible to inundation or isolation by lava. While this discussion has focused mostly on lava flow hazards, volcanic ash and tephra (all particle sizes) and gases are also pose threats, but how people and government approach the ideas of mitigating lava flows hazards with engineered measures is expensive and the cultural, environmental, legal and political ramifications of doing mean that their use is uncertain in future eruptions.

10. Analyzing various factors influencing physical vulnerability

As explained in the introductory sections of this document, the aim was to identify critical factors influencing physical vulnerability, making use of a conceptual framework that allowed the identification of the typical interventions to address physical vulnerability. A summary of the typical interventions is given in Table 10. The summary shows the variety of measures employed for various types of hazard and in the different contexts. Each hazard, each context shows its own type of typical intervention. Still, the distinction made between the various policy instruments employed by the public sector (varying from structural measures to legal, economic, information as well as preparedness measures) and the measures developed and implemented by the private sector and civil society prove to be a useful one to analyze the responses to the variety of hazards in a variety of context.

Based on the various analysis of the various interventions a synthesis is made of the various factors influencing physical vulnerability (Table 11). Aiming at a comprehensive overview; the factors are not only classified according to 'social' and 'economic', but also to 'institutional' and 'political' factors.

Even this classification might be reconsidered in further studies as it remains arguable which factors belong to which category. Factors influencing physical vulnerability that clearly come out of this overview include:

Social factors:
- Demographics
- Social cohesion
- Educational level, technological development, professional knowledge and skills
- competence and transparency in public administration
- Risk awareness
- Risk perception

Economic factors:
- Economic development
- Income disparity
- Resource availability
- Ownership

Institutional
- Coordinative efforts
- Corporate responsibility
- Effective land use planning

Political
- Resource availability
- Risk awareness
- Strategic thinking

A number of these factors are described and explained in much more detail and depth in the various case studies.

Table 10. Interventions to deal with physical vulnerability

Cases	Physical structures	Land use planning	Building regulations	Other regulations	Economic incentives	Information and awareness mechanism	Response measures	Private institutions	Civil society institutions
Drought									
Negev	- Water reservoirs - Irrigation structures - Water purification				- Drought line	- Extension and agronomic advice	- Compensation measures	- Technological innovation	- Cooperative action |purchase, cultivation, credit) - Research
Earthquakes									
Overall	- Infrastructure system	- Urban planning	- Building codes	- Safety standards		- Information campaigns	- Radio systems - Stockpiling of vulnerable materials - Scenario construction	- Insurance and risk transfer - Ownership - New technologies and materials	- Charity work
Islands Aegean Sea		- Land use and urban planning	- Building codes	- Building permissions - Building inspection	- Insurance and risk transfer			- Corporate responsibility - Real estate	-
Abruzzo	- Critical facilities and public structures	-	- Building codes	- Building control		- Alert system			
French West Indies		- Risk prevention plans	- Anti-seismic regulations	- National Seismic Plan	- Anti-seismic building prime	- Awareness/media campaigns - Training construction works	- National emergency exercise - Emergency kits	- Insurance (hardly operational)	- Regional councils
Floods									
Gelderland rivers	- Structural flood protection measures	- Land use planning		- Water management		- Media campaigns	- Evacuation plans - Emergency plans		- Self-awareness
Dresden	- Structural flood protection measures	- Land use planning		- Flood control Act - Flood hazard mapping			- Recovery funds	- Insurance - Private precautionary measures	- Voluntary disaster operation
England	- Flood products	- Spatial plans for avoidance and mitigation	- Voluntary code little on flooding)	- Building control and inspection - Planning conditions - Regulations on locations	- Grants scheme for resilience measures - Enforcement schemes	- Guides on flood resilience - Flood fairs - National Flood Forum	- Emergency evacuation plans - Demountable flood defences - Community-based response	- Disaster continuity planning - Flood insurance	- Local flood action committees - Floodplain communities - River groups - Flood fairs - National Flood Forum

							measures		

Table 10. Interventions to deal with physical vulnerability (cont.)

Cases	**Physical structures**	**Land use planning**	**Building regulations**	**Other regulations**	**Economic incentives**	**Information and awareness mechanism**	**Response measures**	**Private institutions**	**Civil society institutions**
Forest fires									
Portugal	- Forestation programmes - Prescribed fires	- Land use planning			- Financial incentives for forest products		- Fire fighting	- Forest owner associations	
Volcanoes									
Hawaii	- Engineering mitigation solutions	- Land use planning				- Information for individual precautionary measures	-	- Residential insurance - Protective measures -	

Table 11. Factors influencing physical vulnerability

Factors	Social	Economic	Institutional	Political
Cases				
Drought				
Negev	- Social cohesion - Demographic composition - Knowledge - Awareness - Risk perception	- Technological development - Access to knowledge - Economic welfare		- Research and development
Earthquakes	-			
Overall	- Populations growth - Demographic composition - Awareness - Willingness/preparedness of community	- Economic welfare - Risk transfer and insurance system - Financial resources - Ownership	- Corruption - Transparency - Redundancy - Spatial planning process - Inspection capacity - Integrity of construction sector - Low qualified professionals - Limited critical facilities	- Budget allocation - Risk perception politicians
Islands Aegean Sea	- Demographic composition - Immigration - Health status - Awareness - Access to information - Lack of experience - Population density - Settlement remoteness/ abandonment - Isolation	- Dependence on vulnerable economic sector (e.g. tourism) - Economic welfare - Income disparity (regional and individual)	- Access to decision making - Redundancy - Limited critical facilities - Multiple administrative levels/coordination - Public-private Partnership	- Lack of participation in decision-making - Risk culture
Abruzzo	- Awareness - Access to information	- Economic risk - Opportunism - Short term profits	- Uncertainty - Location critical facilities	- Risk culture - Alignment of risk measures (i.e. building codes)
French West Indies	- (illegal) immigration - Population density - Lack of awareness/information (tourists) - Risk perception	- Need for social housing - Risk insurance system	- Low qualified professionals - Location of critical facilities - Communication and transportation networks - Means of communication	- Competence local authorities
Floods				
Gelderland rivers	- Risk awareness - Recognition of the public good	- Economic interests - Short term gains	- Communication - Communication and transportation networks - Integration of land use planning and water management	- Risk awareness - Strategic thinking - Political courage
Dresden	- Risk awareness	- Ownership	- Land use planning - Risk information - Coordination	- Risk awareness
Malyasia	- Social transformation - Indigenous knowledge - Collective memory - Demographic composition - Educational level - Knowledge	- Welfare culture - Ownership	- Modernization - Learning process	-
England	- Population density - Population growth - Risk awareness	- Economic transformation - Income disparity - Welfare development - Urban expansion - Technological development	- Regulation compliance - Corruption - Uncertainty - Critical infrastructure - Coordination	- Land use planning and policies - Containment policies - Recognition of area of risk

Factors	Social	Economic	Institutional	Political
Cases				
Forest fires				
Portugal/ Greece	- Migration - Demographic composition - Land abandonment - Population density - Arson - Public awareness	- Expansion of risk activities - Economic market (for forest products) - Financial incentives	- Early detection - Land use planning - Institutional coordination - Clear responsibilities	- Support (political and monetary) for fire prevention, monitoring and early warning - Conflicting policies
Landslides				
Chianti region	- Knowledge	- Economic development - Land management	- Land use planning	
Volcanoes				
Hawaii	- Population growth - Educational level - Heterogeneity of ethnic groups - Risk culture	- Income level	- Infrastructure network - Key in infrastructure - Land use planning	- Risk culture

11. Final remarks

This task has explored the relation between social, economic and physical vulnerability. Multiple relationships can be explored between these vulnerability types. A few of these relationships have been studied in depth in other tasks. The main initial concern behind this task was the often overlooked influence of social, cultural and economic factors that contributes to physical vulnerability.

Eventually the concern was to indentify the influence of social and economic vulnerability on physical vulnerability. To explore this relationship, typical interventions to deal with physical vulnerability were identified and described. As the relationship of physical vulnerability on particularly social and economic has been extensively studied and implicitly also dealt with in other working packages of the ENSURE project; the reverse relationship has received only limited attention in this work.

From case studies as well as from literature review it is evident that the physical environment and its quality is shaped by its social and economic environment. The main challenge was to unravel which and how social and economic factors influence the physical environment. The case studies have supplied detailed insight into the nature and strength of the various relationships. Concluding what are the social and economic factor influencing physical vulnerability unavoidably leads to an oversimplification and will loose much of the specificities of each hazard type and its specific context.

Rather than to formulate some final conclusions we will conclude with some final statements and dilemmas that should be further explored and investigated:

- Analysis of success and failures of risk management strategies is a useful lens to analyze the different types of vulnerabilities and their relationships.
- A key part of this task was the conceptualization that physical *vulnerability* is affected by social and economic *factors*, as well as social and economic *vulnerability*; and subsequently *physical vulnerability* affects *social and economic vulnerability* via a feedback process. Different influencing factors rather than only vulnerability types in this sense are key to be considered. If the analysis would only focus on the various vulnerability types, the analysis would be too narrow and would omit the wider chain of causal linkages in vulnerability framework
- Institutional and political factors should be explicitly considered in the vulnerability framework and are by no means synonyms with institutional and political vulnerability.
- Similar factors could have dual –opposite- effect on physical vulnerability as the latter included two components: susceptibility to loss as well as recovery capacity; e.g. Some social and economic factors have negative as well as positive effects on physical vulnerability. E.g. economic development and population concentration could have negative effect on the physical vulnerability if it concerns the susceptibility to loss; but at the same time could lead to reduced vulnerability if it concerns to the enhanced capacity to recover.
- Risk perception proves to be a crucial element in understanding the actual vulnerability of persons, groups, enterprises and communities. Physical vulnerability might be enhanced by a 'wrong' risk perception, might differ according to different social groups and should be explicitly considered in dealing with vulnerabilities.

References

Abbattista, F. *et al.* (2005). *Assessment of landslide susceptibility: application to rapid flows at Cervinara* (Southern Italy). Anno XIII Numero 1 Gennaio/Marzo

Alexandrian, D., Esnault, F. & Calabri, G. (1999). Forest Fires in the Mediterranean Area. *Unasylva - Mediterranean Forests*, 197(50).

AMRA. Retrieved from http://www.amracenter.com/laquila/index.html

ASCE, American Society of Civil Engineers (1995). *Northridge Earthquake: Lifeline Performance and Post-Earthquake Response*. Schiff, A.J. (Ed.), Technical Council of Lifeline Earthquake Engineering, Monograph No: 8.

Bankoff G., Frerks, G. & Hilhorst, D. (2004). *Mapping vulnerability. Disasters, development & people*. London: Earthscan.

Bassi, S., Kettunen, M., Kampa, E. & Cavalieri, S. (2008). *Forest fires: causes and contributing factors to forest fire events in Europe*, Study for the European Parliament's Committee on Environment, Public Health and Food Safety.

Bezuyen, M.J., Van Duin, M.J. & Rosenthal, U. (1995). Watersnood 1995, Het verloop en succes van een grootschalige evacuatie. *Bestuurskunde*, 4(8), 353-360.

Blaikie, P., Cannon, T., Davis, I. & Wisner B. (1994). *At Risk: Natural Hazards, People's Vulnerability, and Disasters*. London: Routledge.

Bohlen, C. (1999, August 20). Turkish earthquake survivors blame corruption. New York Times. http://www.wakingbear.com/turkey1.htm.

Bosher, L. (Ed.) (2008). *Hazards and the Built Environment*. London: Taylor and Francis.

Brunetti, M., Buffoni, L., Mangianti, F., Maugeri, M. & Nanni, T. (2004). Temperature, Precipitation and Extreme Events during the Last Century in Italy. *Global Planetary Change*, 40, 141-149.

Brunetti, M., Maugeri, M. & Nanni, T. (2000). Variations of Temperature and Precipitation in Italy from 1866 to 1995. *Theoretical and Applied Climatology*, 65, 165-174.

Bundesregierung (2006). *Maßnahmen zum Hochwasserschutz seit 2002*. Retrieved on 09.06.2009 from http://www.bundesregierung.de/nn_774/Content/DE/Artikel/2001-2006/2006/04/2006-04-10-massnahmen-zum-hochwasserschutz-seit-2002.html

Burby, R.J., Nelson, A.C., Parker, D.J. & Handmer, J.W. (2001). Urban Containment Policy and Exposure to Natural Hazards: Is there a Connection?. *Journal of Environmental Planning and Management*, 44,(4), 475-490

Cartier S. and Colbeau-Justin L. (2007). *Le risque sismique en Martinique : de sa perception à son intégration dans des pratiques préventives*, In: Livre Blanc, Conseil Économique et social du Conseil Général de la Martinique.

Chang, S.E. and Nojima, N. (1998), *Measuring Lifeline System Performance: Highway Transportation Systems in Recent Earthquakes*. Proceedings of the Sixth U.S. National Conference on Earthquake Engineering, Seattle, Washington, paper no.70.

CEN, European Committee for Standardization (2009). Retrieved from http://www.cen.eu/cenorm/sectors/sectors/construction/eurocodes/index.asp

Centre for Advanced Engineering (1997). *Risks and Realities – A Multi-disciplinary Approach to the Vulnerability of Lifelines to Natural Hazards*, New Zealand.

CETE (2005). *Mission Guadeloupe février 2005 : retour relatif aux observations, résultats et pistes de travail*, Retrieved from: http://www.rdtrisques.org/projets/passerelle/reunion13oct/guadeloupe-AMD.pdf

Chan, N.W. & Parker, D J. (1996). Response to dynamic flood hazard factors in peninsular Malaysia. *The Geographical Journal*, 162(3), 313-325

Coburn, A. (1995), Disaster Prevention and Mitigation in Metropolitan Areas: Reducing Urban Vurnerability in Turkey, In: Parker, R.S., Kreimer, A. & Musinanghe, M. (Eds.). *Informal settlements, environmental degradation, and disaster vulnerability: The Turkey Case Study, The World Bank and The International Decade for Natural Disaster Reduction* (IDNDR), 65-94.

Commission Regulation (EC) No 1727/1999 of 28 July 1999 laying down certain detailed rules for the application of Council Regulation (EEC) No 2158/92 on protection of the Community's forests against fire

Commission Regulation (EC) No 2121/2004 of 13 December 2004 amending Regulation (EC) No 1727/1999 laying down certain detailed rules for the application of Council Regulation No 2158/92 on protection of the Community's forests against fire and Regulation (EC) No 2278/1999 laying down certain detailed rules for the application of Council Regulation (EEC) No 3528/86 on the protection of the Community's forests against atmospheric pollution

Commission Regulation (EC) No 804/94 of 11 April 1994 laying down certain detailed rules for the application of Council Regulation (EEC) No 2158/92 as regards forest-fire information systems

Construction Industry Research and Information Association (2005). *Improving the Flood Resilience of Buildings through Improved Materials, Methods and Details*. Report No. WP2c – Review of Existing Information and Experience (Final Report), London: CIRIA

Corriere della Sera (18th April, 2009). Dossier segreto, Genio civile sequestrato.

Costa, L., Badeck, F. & Thonicke K. (2007). *Sensitivity of Portuguese Forest Fires to Land Use and Climatic Factors*, Contribution to the International Wildland Fire Conference, 13-17, Seville, Spain, May 2007

Council Regulation (EC) No 787/94 of 29 March 1994 on special measures for farmers affected by the 1992/93 drought in Portugal

Council Regulation (EEC) No 2158/92 of 23 July 1992 on protection of the Community's forests against fire

Cross, J.A. (2001). Megacities and small towns: different perspectives on hazard vulnerability. *Environmental Hazards*, 3, 63-80.

Dalezios, N.R., Loukas, A., Vasiliades, L. & Liakopoulos, E. (2000). Severity-Duration-Frequency Analysis of Droughts and Wet Periods in Greece. *Hydrological Science Journal*, 45, 751-769.

Dandoulaki, M. & Delladetsima, P. M. (Eds.) (2003). Proceedings of the International Seminar "*Restoration of historic buildings in seismic areas: The case of settlements in the Aegean*", Lesvos, 24-26 May, 2001.

Dandoulaki, M., (1995), Temporary housing after earthquakes: The Greek experience during the period 1986-1995. Proceedings of the Conference "*Regional development, planning and the Environment in the framework of United Europe*", Volume II: Regional planning. Publication Topos, 240-255

De Marchi, B., Scolobig, A., Delli Zotti, G, & Dell Zotto, M. (2006). *Risk construction and social vulnerability in an Italian Alpine Region*, FLOODsite Report No. T11-2006-08. HR Wallingford: Wallingford UK

Decision 2003/785/EC of the European Parliament and of the Council of 9 October 2003 on the mobilisation of the EU Solidarity Fund in accordance with point 3 of the Interinstitutional Agreement of 7 November 2002 between the European Parliament, the Council and the Commission on the financing of the European Union Solidarity Fund, supplementing the Interinstitutional Agreement of 6 May 1999 on budgetary discipline and improvement of the budgetary procedure (damage caused by the Prestige oil tanker, by the earthquake in Molise and Apulia, and by the eruption of Mount Etna)

Del Moral Ituarte, L. & Giansante, C. (2000). Constraints to drought contingency planning in Spain: The hydraulic paradigm and the case of Seville. *Constraints Drought Contingency Planning*, 8, 93-102.

Delladetsima, P.-M., Dandoulaki, M. & Soulakellis, N. (2006). An Aegean island earthquake protection strategy: an integrated analysis and policy methodology. *Disasters*, 30(4), 469–502.

Department for Communities and Local Government (DCLG). (2006a) *Planning Policy Statement 25: Development and Flood Risk*, *December*. London: DCLG

Department for Communities and Local Government (DCLG) (2006b). *Code for Sustainable Homes. A step-change in sustainable home building practice*. London: DCLG

Department for Communities and Local Government (DCLG) (2007). *Improving the flood performance of new buildings. Flood resilient construction*. London: DCLG

Department for Environment, Food and Rural Affairs (Defra) (2005), *Making Space for Water. Taking forward a new Government Strategy for flood and coastal erosion risk management in England*. First Government Response to the autumn 2004 Making Space for Water consultation exercise. London: Defra

Department for Environment, Food and Rural Affairs (Defra) (2008a). *Consultation on policy options for promoting property-level flood protection and resilience*. London: Defra.

Department for Environment, Food and Rural Affairs (Defra) (2008b). *Summary of responses to the consultation on policy options for promoting property-level flood protection and resilience 30th July to 31st October 2008*. London: Defra

de Vanssay, B. (2007). *Vulnérabilité sociale face au risque sismique*, Retrieved from: http://vor.grenoble-inp.fr/servlet/com.univ.utils.LectureFichierJoint?CODE=1193392063170&LANGUE=0&ext=.ppt.

DKKV, Deutsches Komitee für Katastrophenvorsorge e.V. (Ed.) (2003). *Hochwasservorsorge in Deutschland – Lernen aus der Katastrophe 2002 im Elbegebiet*. Bonn: DKKV

DGRF (2007). *Forest fires 2007 report*. Direcção Geral dos Recursos Florestais.

Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment.

Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks.

Entec UK Ltd. (2007). *Developing the Evidence Base for Flood Resilience*, FD2607, Preliminary Report, September. London: Defra

Environment Agency (2009). *TE2100 Plan and Consultation Document: Managing flood risk through London and the Thames estuary*. Bristol: Environment Agency

Escaleras, M., Anbarci, N. & Register, C.A. (2007). "*Public sector corruption and major earthquakes: A potentially deadly interaction*"

Eurocode 8. Retrieved from http://www.eurocode-online.de/cn/J-CAD1228AD25047C25A3E135ACA20E842.4/bGV2ZWw9dHBsLWdlZnN1Y2hlcmdlYm5pcw**.html;jsessionid=CAD1228AD25047C25A3E135ACA20E842.4

Fleischhauer, M. (2006). Spatial Planning and the Prevention of Natural Risks in France. In: Fleischhauer, M., Greiving, S. & S. Wanczura (eds.), *Natural Hazards and Spatial Planning in Europe* (37-54). Dortmund: Dortmunder Vertrieb für Bau- und Planungsliteratur.

Fleischhauer, M., Greiving, S. & S. Wanczura (eds.) (2006). *Natural Hazards and Spatial Planning in Europe*. Dortmund: Dortmunder Vertrieb für Bau- und Planungsliteratur.

Fornés, J.M., de la Hera, A. & Llamas, M.R. (2005). The silent revolution in groundwater intensive use and its influence in Spain. *Water Policy*, 10, 1-16.

GEMITIS (1999) *Evaluation des dommages directs d'un séisme sur la ville de Nice: scénarios de risque*. Report BRGM R40612, 171 pp

Gregory, P. & Rothstein, P.J. (foreword) (2007). *IT Disaster Recovery Planning for Dummies*. For Dummies, 286-287. Retrieved from http://www.library.cornell.edu/colldev/mideast/tquak.htm.

Grünewald, U. (2003): Die „Augustfluten 2002 im Elbegebiet" – in welches Licht haben sie uns gestellt und in welches sollten wir sie stellen? Vortrag zum Tag der Hydrologie am 20./21.3.2003 in Freiburg. In: *Forum für Hydrologie und Wasserbewirtschaftung*, H. 4/03.

ICBR, Internationale Commissie ter Bescherming van de Rijn. (2002). *Voorzorgsmaatregelen tegen hoogwater. Maatregelen en hun effectiviteit*.

Intermedia Dom Immeuble BTB (2008). *Dossier de Presse 'Face au risque sismiquw, chaque jour, je me prépare'*, Retrieved from http://www.brgm.fr/AgendaNews/dcenewsFile?ID=764

Jann, W. & Wegrich, K. (2005). Theories of the Policy Cycle. In: Fischer, F., Miller, G. & Sidney, M.S. (eds.), *Handbook of Public Policy Analysis: Theory, Politics, and Methods* (43-62). Bora Raton: CRC Press

Jarva, J. & Virkki, H. (2006). Dealing with Natural Hazards: Practice in the Finnish Spatial Planning System. In: Fleischhauer, M., Greiving, S. & S. Wanczura (eds.), *Natural Hazards and Spatial Planning in Europe* (19-36). Dortmund: Dortmunder Vertrieb für Bau- und Planungsliteratur.

Katsoulis, B.D. & Tsangaris, J.M. (1994). The state of the Greek Environment in recent years. *Ambio*, 23, 274-279.

Kinzer, S. (1999, August 17). *The Turkish quake's secret accomplice: Corruption*. New York Times.

Klijn, F., Van Buuren, M. & Van Rooij, S.A.M. (2004). Flood-risk Management Strategies for an Uncertain Future: Living with Rhine River Floods in The Netherlands?. *Ambio*, 33(3), 141-147.

Koppenjan, J.F.M. & Hagelstein, G.H (1995). Wateroverlast 1995. *Bestuurskunde*, 4(8), 338-342.

Kreibich, H. & Thieken, A.H. (2007). Coping with Floods in the City of Dresden, Germany. *Natural Hazards*, online first

L'Espresso (2009). *Minutes of Commissione Grandi rischi meeting*. Retrieved from http://speciali.espresso.repubblica.it//pdf/terremoto/verbale.pdf

La Repubblica (9th April 2009). L'allarme inascoltato dal ministro. Norme antisismiche, basta rinvii, 7.

La Repubblica (10th April 2009). Matteoli: "L'ho scritto a Tremonti e al premier un errore far slittare le norme antisismiche, 4.

La Repubblica (18th April 2009). Così il sindaco chiese aiuto prima del sisma.

Laska, S. & Wetmore, F. (2000). Reducing Flood Loss Potential by Flood-Proofing in the USA, In: Parker, D. J. (Ed.) *Floods, Volume 1* (268-276). London: Routledge.

Law 225/92 "Institution of the Service of Civil Protection".

Leone, F. (2007). *Caractérisation des vulnérabilités aux catastrophes « naturelles » : contribution à une évaluation géographique multirisque ((Mouvements de terrain, séismes, tsunamis, éruptions volcaniques, cyclones)*, Research Dissertation (French *Habilitation à Diriger des Recherches*), University of Paul Valéry – Montpellier III.

Leone, F. and Mavoungo, J. (2000). *Le séisme du 8 juin 1999 de la Martinique, résultats de l'enquête post-sismique sur les personnes se trouvant dans les bâtiments*, S.L: S.N., GEODE CARAIBE, Université des Antilles et de la Guyane.

Lewis, J. (2005). Earthquake destruction: Corruption on the fault line. In: Transparency International, *Global corruption report 2005*, 23–30.

Livada, I. & Assimakopoulos, V.D. (2007). Spatial and temporal analysis of drought in Greece using the Standardized Precipitation Index (SPI). *Theoretical and Applied Climatology,* 89, 143-153.

Mavoungo, J. (1997). *Le risque sismique en Martinique : Analyse et évaluation des principaux facteurs de vulnérabilité de la population urbaine. L'exemple de Fort-De-France*, S.L.: S.N., Université des Antilles et de la Guyane, Mémoire de Maîtrise de géographie.

Mavoungo, J. and Balandier, P. (2008). Les Antilles françaises : entre risque sismique et stratégies locales de prévention, *Études caribéennes,* 7/2007, Les risques naturels majeurs dans la Caraïbe, Retrieved from:http://etudescaribeennes.revues.org/document289.html.

May, J.V. & Wildavsky, A.B. (1978). *The Policy Cycle*. California: Sage Publications, Inc.

Mendes, C., Feliciano, D., Tavares, M. & Dias, R. (2004). *The Portuguese Forest*. Country level report delivered to the EFFE Project – Evaluating Financing in Forestry in Europe.

Menoni, S. 2001. Chains of damages and failures in a metropolitan environment: some observations on the Kobe earthquake in 1995. *Hazardous Materials*. 86(1-3): 101-119.

Morrow, B.H. (1999). Identifying and Mapping Community Vulnerability. *Disasters*, 1999, 23(1): 1-18

Mousteraki, K., Dandoulaki, M. & Symeonidis, S. (2009). *Assessment of an alternative housing reconstruction policy after the 1995 Grevena-Kozani (N.Greece) earthquake: Construction of standardized units in private lots*, Proceedings of EGU 2009, European Geosciences Union General Assembly, Vienna, 19-24 April 2009.

Nativ, R. (2004). Can the desert bloom? Lessons learned from the Israeli case. *Groundwater*, 42, 651-657.

NEDIES, Natural and Environmental Disaster Information Exchange System (2001). *Flood 23 January 1995 Limburg, Gelderland*. Retrieved from http://nedies.jrc.it/index.asp?result=2&ID_Disaster=167&idm=33.

Parker, D.J. (1995) Hazard transformation and hazard management issues in the London megacity. *Geojournal*, 37(3), 313-328

Parker, D.J. (2000). Introduction to floods and flood management, In: Parker, D.J. (Ed.) *Floods, Volume 1* (3-40). London: Routledge.

Pelling, M., Özerdem, A. & Barakat, S. (2002). The macro-economic impact of disasters. *Progress in Development Studies*, 2(4), 283-305.

Penning-Rowsell, E.C. & Parker, D.J. (1987). The indirect effects of floods and benefits of flood alleviation: evaluating the Chesil Sea Defence Scheme. *Applied Geography*, 7, 263-288.

Peñuelas, J., Lloret, F. & Montoya, R. (2001). Severe drought effects on Mediterranean woody flora in Spain. *Forest Science*, 47, 214-218.

Pereira, M., Domingos, T. & Vicente, L. (2004). *Portugal Millennium Ecosystem Assessment: State of the Assessment Report.* Lisbon: Centro de Biologia Ambiental, Faculdade de Ciências da Universidade de Lisboa.

Petrow, T., Thieken, A.H., Kreibich, H., Bahlburg, C.H. & Merz, B. (2006). Improvements on Flood Alleviation in Germany: Lessons Learned from the Elbe Flood in August 2002. *Environmental Management*, 38, 717-732

Picarelli, L. & Russo, C. (2004). *Remarks on the mechanics of slow active landslides and the interaction with man-made works*. Proceedings of World Conference on Landslides, Rio the Janeiro 28 June – 1 July 2004. Balkema.

Piccarreta, M., Capolongo, D. & Boenzi, F. (2004). Trend analysis of precipitation and drought in Basilicata from 1923 to 2000 within a southern Italy context. *International Journal of Climatology*, 24, 907-922.

Piñol, J., Terradas, J. & Lloret, F. (1998). Climate warming, wildlife hazard, and wildfire occurrence in coastal eastern Spain. *Climate Change*, 38, 345-357.

RICHTER National Exercise (2008), Retrieved from: http://www.martinique.pref.gouv.fr/pages/newsRicher-1.pdf, http://www.martinique.pref.gouv.fr/pages/newsRicher-2.pdf

Roberts, C.R. (2002). Drought management in the Rio Guadalhorce region of Andalucia, southern Spain. *Land Degradation and Development*, 13, 151-163.

Rose, A. (2004). Defining and Measuring Economic Resilience to Earthquakes. *Disaster Prevention and Management*, 13(4), 307-314

Sapoutzaki, K. & Dandoulaki, M. (2006). Coping with Seismic Risk in Greece: The Traditional Merits of the System and the Challenges of the Future. In: Fleischhauer, M., Greiving, S. & S. Wanczura (eds.), *Natural Hazards and Spatial Planning in Europe* (77-96). Dortmund: Dortmunder Vertrieb für Bau- und Planungsliteratur.

Sauri, D. & del Moral, L. (2001). Recent developments in Spanish water policy: Alternatives and conflicts at the end of the hydraulic age. *Geoforum*, 32, 351-362.

Stansbury, N. (2005). Exposing the foundations of corruption in construction. In: *Global Corruption Report*, Special Focus: Corruption in Construction and Post Conflict Reconstruction.

Stokkom, van H.T.C., Smits, A.J.M. & Leuven, R.S.E.W. (2005). Flood Defense in The Netherlands. *Water International*, 30(1), 76-87

Suarez-Villa, L. & Walrod, W. (1999). Losses from the Northridge Earthquake: Disruption to High-technology Industries in the Los Angeles Basin. *Disasters*, 23(1), 19-44.

Swearingen, W.D. (1992). Drought hazard in Morocco. *Geographical Review*, 82(4), 401-412.

Tal, A. (2006). Seeking sustainability: Israel's evolving water management strategy. *Science*, 313, 1081-1084.

The City of Kobe (2008). *The report on The Great Hanshin-Awaji Earthquake – Statistics and Restoration Progress*.

Thieken, A.H., Kreibich, H., Müller, M. & Merz, B. (2007). Coping with Flood-Affected Residents in Germany in 2002. *Hydrological Sciences*, 52(5), 1016-1037

Tierney, K.J. & Dahlhamer, J.M. (1998). Earthquake Vulnerability and Emergency Preparedness among Businesses. In: Shinozuka, M., Rose, A. & Eguchi, R.T. (Eds.). *Engineering and Socioeconomic Impacts of Earthquakes*, Monograph Series, Multidisciplinary Center for Earthquake Engineering Research, A National Center of Excellence in Advanced Technology Applications.

Tierney, K.J. (1997). Business Impacts of the Northridge Earthquake. *Journal of Contingencies and Crisis Management*, 5(2), 87-97.

Tol, R.S.J. & Langen, A. (2000). A Concise History of Dutch River Floods. *Climatic Change*, 46, 357-369.

Tol, R.S.J., Van der Grijp, N., Olsthoorn, A.A. & Van der Werff, P.E. (2003). Adapting to Climate: A Case Study on Riverine Flood Risks in the Netherlands. *Risk Analysis*, 23(3), 575-583.

Tsakiris, G., Pangalou, D. & Vangelis, H. (2007). Regional drought assessment based on the Reconnaissance Drought Index (RDI). *Water Resource Management*, 21, 821-833.

Vicente-Serrano, S.M., González-Hidalgo, J.C., de Luis, M. & Raventós, J. (2004). Drought patterns in the Mediterranean area: the Valencia region (eastern Spain). *Climate Research*, 26, 5-15.

Wanczura, S. (2006). Dealing with Natural Hazards in Poland: The Example of the Local Flood Warning System of Klodzko. In: Fleischhauer, M., Greiving, S. & S. Wanczura (eds.), *Natural Hazards and Spatial Planning in Europe* (127-144). Dortmund: Dortmunder Vertrieb für Bau- und Planungsliteratur.

Xanthopoulos, G. (2004). *Who should be responsible for forest fires? Lessons from the Greek experience.* Proceedings 'II International Symposium on Fire Economics, Planning and Policy: A Global View', 19-22, Cordoba, Spain, April 2004

Appendix I: A comparison between Israeli and Spanish water use categories

It is interesting to note that while a large scope of measures were taken in Israel much fewer measures were taken by European countries up to date, despite the fact that many European and Mediterranean countries are subjected to droughts such as Greece (Katsoulis and Tsangaris, 1994; Dalezios *et al.*, 2000; Livada and Assimakopoulos, 2007; Tsakiris *et al.*, 2007), Italy (Brunetti *et al.*, 2000, 2004; Piccarreta *et al.*, 2004), Spain (Piñol *et al.*, 1998; Peñuelas *et al.*, 2001; Vicento-Serrano *et al.*, 2004; Fornés *et al.*, 2005) and Morocco (Swearingen, 1992). This can be clearly seen when a comparison is made between Israel and Spain. The differences, as shown in the Table below, may reflect not only the different geographical setting but also historical, legal and cultural differences.

Category	Israel	Spain	Remarks and References
Water Regulations	High	Medium/ Low	Since 1985 the construction of new wells for ground water requires a license in Spain. Still only 25% of the well owners are registered (Fornés *et al.*, 2005)
Water Transfer	High	Poor	For ideological (why to loose an important resource?) and practical (the division of Spain into autonomous states) reasons water transfer in Spain is minimal (Sauri and del Moral, 2001)
Water Harvesting (dams, water reservoirs)	High	High	See Tal (2006) for Israel and Roberts (2002) for Spain
Waste Water Purification	High	Low/ Medium	In Israel, 91% of the sewage is treated and 73% recycled, in comparison to 20% in Spain (second to Israel) and only 2.5% in USA (Tal, 2006). In 2003, in Israel, 33% of the agricultural water consisted of recycled water (Nativ, 2004). Furthermore, although agriculture extended 16 fold in the last 60 years in Israel, the amounts of drinkable water for agriculture dropped steadily (Tal, 2006)
Irrigation Techniques	High	Medium	Water transfer in open channels and flood irrigation are still in practice in Spain (Roberts, 2002) while not existent in Israel. Drip irrigation in Israel is much more commonly used
Sea Water Desalination	Medium	Low	See Nativ (2004) and Tal (2006) for Israel and Roberts (2002) for Spain

Comparison between Israeli and Spanish Water Use Categories

In both countries, water quality was severely affected (Nativ, 2004; Roberts, 2002). Yet, unlike Spain where water rationing was implemented (del Moral Ituarte and Giansante, 2000), it did not yet take place in Israel, attesting to fairly good, but insufficient measures taken by the state.

Appendix II: Tables case three islands in Aegean Sea

Appendix II.A: Brief presentation of the case study islands

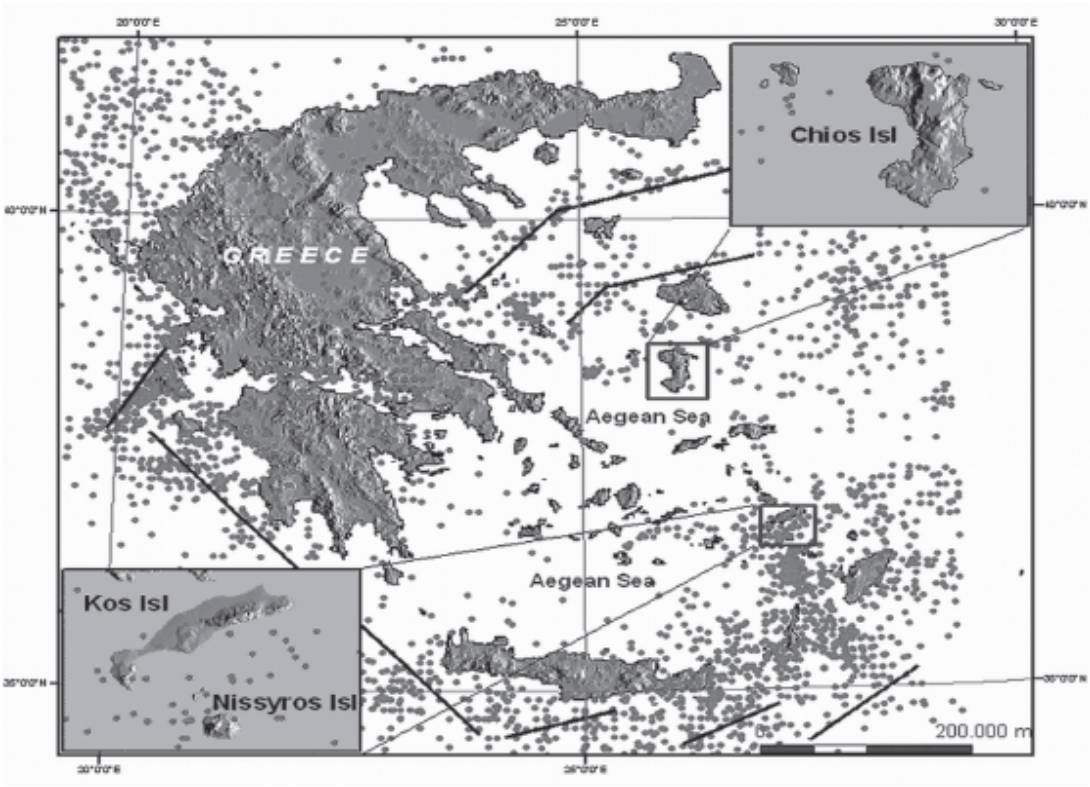


Figure A.1: Location map of the islands of Chios, Kos and Nissyros and earthquake epicenters (Ms>5) in the Aegean Sea

Source: Delladetsima *et al.,* 2006

	Island of Chios	Island of Kos	Island of Nissyros
Administrative level	Prefecture capital; with various municipalities.	Sub-prefecture capital; with municipalities.	Local authority. The island is a municipal unit.
Demographic composition	Large percentage of dependent and elderly members of the population in the island's hinterland.	Young demographic structure and foreign population permanently residing on the island.	Very high percentage of elderly members in the population structure.
Human geography	Population increases during summer months mostly connected to people of local origin; they do not permanently reside on the island. High degree of population concentration in the main town of Chios.	Extraordinary population rise during the summer months due to tourism. Fairly balanced settlement growth and population distribution.	Marked population increases during the summer months, especially highly mobile daily visitors.
Building stock and settlement structure	There is one main, dominant urban centre and a vast number of declining smaller settlements, with aged building stock, in the hinterland.	Balanced settlement structure with new building stock. Large numbers of big hotel units scattered all over the island.	Old building and poorly maintained stock. Buildings constructed using local systems. On the whole, settlements, with aged building stock.
Accessibility / transport conditions	The island has a port and airport. Fairly good road network, but some of its segments are highly problematic. Efficient airport coverage. Existence of an important complementary port installation in the west of the island. A prevailing highly problematic connection between the main port and the core town of Chios.	The island has a port, airport and good road network. Highly efficient airport coverage. There is, however, no second port installation. In addition, the island is characterised by a problematic connection between the main port and the core town of Kos.	The island has a port and heliport, but a deficient road network. Nissyros suffers from a severe lack of external transport connections, particularly during winter months.
Emergency institutions	The island possesses all prefecture/regional and local authority institutions and services. It also has a major hospital unit. Of relevance is the extended role of the army in service provision during normal and emergency periods.	Kos has a rather efficient administrative structure. The island provides some (as a sub-prefecture) regional authority institutions/services and all local authority ones. It relies a lot on the extended role of the army in emergency situations. The hospital unit is small in relation to the scale of demand.	Huge service deficiencies. There is an absolute dependence on the adjoining island of Kos.

Table A.1: Main features of the case study islands related to seismic vulnerability and emergency response capability

(Source: Delladetsima et al. 2006)

Appendix II.B: Social and economic factors influencing physical and social earthquake vulnerability

Population characteristics and human geography fluctuations **Social factor: Aged population**			
Physical vulnerability		**Social vulnerability**	
Impact on susceptibility to loss	**Impact on recovery capacity**	**Impact on susceptibility to loss**	**Impact on recovery capacity**
Use of old building stock Lack of building maintenance Difficulties/ not willingness to undertake proper upgrading interventions/retrofitting of the buildings Use of old / historic settlements (vulnerability from blockage of escape routes, dangerous falling elements of facades, buildings vulnerable to dangerous adjacent buildings)	Delays in repairing /reinforcing earthquake damaged building stock Difficulties/ not willingness to get loans, to use any incentives/ financial aid in order to repair /reinforce earthquake damaged building stock	Increased human losses due to: Preexisting health problems Mobility difficulties /Limited escape capacity Health fragility	Limited access to aid provision due to mobility difficulties and marginalization Limited access to information Limited access to decision making Difficulties in making a new start in life (moving to a new house, place, village) – Tend to stay longer in temporary housing
Overall situation: VULNERABLE GROUP OF PEOPLE LIVING IN VULNERABLE BUILDINGS AND SETTLEMENTS			
Physical vulnerability aggregates social vulnerability **Social vulnerability aggregates physical vulnerability**			

Social factor: Seasonal population increase			
Physical vulnerability		**Social vulnerability**	
Impact on susceptibility to loss	**Impact on recovery capacity**	**Impact on susceptibility to loss**	**Impact on recovery capacity**
Due to: Tourism			
Construction on unsafe soils (typical examples: on the sea side, on stiff cliffs with view) Fast production of building stock leading to not full implementation of Seismic Design Code, low building quality, use not safe construction materials , such as sea gravel and sand Use of historic building stock without proper seismic retrofitting or next to dangerous buildings Use of historic settlements (vulnerable due to: complicated urban tissue, blockage of escape routes by debris etc.)	Pressures for a fast recovery in order to recuperate tourism might lead to patch things up - Fast recovery versus promoting risk mitigation during recovery Tourism drop after the disaster limits financial resources for safe recovery of buildings and infrastructure	Lack of previous EQ experience might lead to not responding properly during and after the earthquake Limited access to information due to the different language, lack of kinship embeddedness, not knowing the local system might lead to an increase of loss of life and injuries in aftershocks and may limit access to health care and aid provision. Difficulties in evacuation Overburden of critical facilities and emergency resources may be a factor of increase of losses.	Language problems, lack of kinship embeddedness, not knowing the local system limit the capacity of tourists to respond and recover Lack of access to local decision making – Lack of or limited EQ awareness
Overall situation: Population and growth pressures lead to physical and social vulnerability			
Social vulnerability aggregates physical and social vulnerability			
Due to: Visitors of local origin			
Less building maintenance of secondary seasonal housing Parked cars can be destroyed by falling	Not interested in dealing with local recovery and reconstruction: Other alternatives and other priorities	Difficulties in evacuation Overburden of critical facilities and emergency resources	Their income is not affected by the disaster and can support recovery Limited access to info and local deci-

debris/ block escape routes			sion making after they are evacuated
Overall situation: Population pressures lead to physical and social vulnerability			
Due to: Inflow migration (legal and illegal) for seasonal work			
Use of unsafe building stock Not enough power to force seismic safety measures Other more urgent priorities then seismic safety - Lack of awareness	They can facilitate recovery as workforce in the construction sector	Lack of previous experience can lead to not responding properly during and after the earthquake (loss of life, injuries) and to suffering huge psychological impact Losses associated with communication difficulties due to language problems, lack of kinship embeddedness and not knowing the local system	Great difficulties in evacuation –Possible discriminations in aid distribution Lack of kinship embeddedness Loosely connected with the local community and system Limited access to info and local decision making Disaster can create work opportunities Little to lose / Disaster recovery has a different meaning
Overall situation: Population increase leads to physical and social vulnerability			

Social factor: Uneven population distribution			
Physical vulnerability		**Social vulnerability**	
Impact on susceptibility to loss	**Impact on recovery capacity**	**Impact on susceptibility to loss**	**Impact on recovery capacity**
Concentration of exposed population in areas by the seaside and/or in the main urban centre with high building densities – High exposure New buildings next to old in the city Open space in the city overloaded with cars and people – Dangers from falling debris	Focus on areas of high densities – Neglect of remote and low densities areas	Open space in the city overloaded with cars and people – Dangers from falling debris Open space in the city not enough or appropriate to serve as refugee space – Open space overloaded with cars and people – Difficulties in evacuation Loss of life, injuries and loss of health due to inadequacies of services and facilities in areas of high concentration of population (mainly in the main urban centre and or tourist areas) Overburden of emergency facilities and resources in highly populated areas – Neglect areas of low densities	Intensification of internal urbanization after the disaster - Abandonment of the countryside Focus on areas of high densities – Neglect of remote and low densities areas Decision making procedures may lead to an underrepresentation of area of low population densities
Overall situation: Uneven population distribution necessitates differentiated emergency management and recovery planning			
Social vulnerability in concert with physical vulnerability			

Social factor: Fading small settlements (decreasing and aging population, remote, old bldg stock)			
Physical vulnerability		**Social vulnerability**	
Impact on susceptibility to loss	**Impact on recovery capacity**	**Impact on susceptibility to loss**	**Impact on recovery capacity**
Aging building stock and infrastructure – Lack of maintenance and seismic safety interventions Construction sector weak not able to perform sophisticated works of seismic retrofitting (lack of workmanship and knowledgeable technicians and engineers) In remote settlements there are difficulties as regards pre-seismic interventions (difficulties in carrying in materials, unwillingness of workforce to go there).	Many are remote settlements. Difficulties as regards construction works for seismic safety (difficult to carry materials, unwillingness of workmanship to go). Construction sector weak (lack of workmanship, knowledgeable technicians and engineers, sector not able to perform sophisticated works of seismic repair and retrofitting) Promoting risk mitigation through recovery and reconstruction versus sustaining small settlements (In some cases relocation of settlements for safety reasons can lead to abandoning the area and migration)	Low priority for search and rescue Low priority for aid provision: Possibly delays and inadequacies Not enough local human resources and capacity to respond and help those in need	Not enough social and economic dynamism to cope with a disaster – Risk of migration Not enough access to decision making processes to promote a fast and proper recovery / reconstruction Low priority in recovery and reconstruction planning, programming and implementation
Overall situation: VULNERABLE SETTLEMENTS			
Physical vulnerability in concert with social vulnerability			

Factor: Isolation of islands – Transport and accessibility conditions			
Physical vulnerability		**Social vulnerability**	
Impact on susceptibility to loss	**Impact on recovery capacity**	**Impact on susceptibility to loss**	**Impact on recovery capacity**
Cost of construction higher – Materials have to be transported to the area – Less quality in construction Administrative procedures such as obtaining a building permit or having the building inspected, can be difficult and costly, especially if the providers of Services are in another island or in Athens – Low law enforcement Knowledge and know-how on seismic safety infiltrates slower - Limited human resources in the islands	Administrative procedures related to repair and reconstruction can be difficult and costly, especially if Services are based in another island or in Athens Knowledge and know-how on seismic safety infiltrates slower - Limited human resources in the islands	Increase of losses due to delayed response	Administrative procedures related to recovery and reconstruction , can be difficult and costly, especially if Services are based in another island or in Athens Due to transport difficulties small islands may be underrepresented in decision making
Seismic safety of access points (ports, airports, heliports) is in the responsibility of agencies not well connected with local decision making, especially in small islands Possibly low risk perception and awareness of the responsible agencies and enterprises	Dependency on limited access points (ports, airports, heliports) Access to the island depends on private enterprises (shipping and air companies,) participating loosely to local emergency planning	Increase of losses due to delays in external aid inflow Increase of losses due to delays in evacuation of population	

Social factor: Administrative level and decision making procedures			
Physical vulnerability		**Social vulnerability**	
Impact on susceptibility to loss	**Impact on recovery capacity**	**Impact on susceptibility to loss**	**Impact on recovery capacity**
Enforcement of codes lower in islands with not enough or without competent services (building permit offices, laboratories for quality control of materials etc.)	Slower (or none) repair / reinforcement of buildings in islands with not enough or without competent services (building recovery offices, laboratories to control concrete etc.) Administrative procedures related to repair and reconstruction can be difficult and costly, especially if Services are based in another island or in Athens	Different administrative levels are involved. Depending on the administrative level of the island, decision making may take place in another island or in Athens Limited access to decision making and limited power to promote seismic safety measures, especially if the island is small Decision making for emergency planning takes place at a higher level and in another place while islands have to cope with disaster at a local level at least immediately after the disaster	Depending on the administrative level of the island, decision making takes place in another place– Limited access to decision making and limited power to promote seismic safety measures, especially if the island is small. Decision making takes place at a higher level and in another place while islands have to recover based on local potential and resources

Social factor: Institutional framework			
Physical vulnerability		**Social vulnerability**	
Impact on susceptibility to loss	**Impact on recovery capacity**	**Impact on susceptibility to loss**	**Impact on recovery capacity**
National Seismic Design Code is not adjusted to the specificities of local construction. This applies especially to historic buildings and local construction systems. Seismic safety not central in the institutional framework for tourism. - Fast growth versus seismic safety.	Repair techniques and methods promoted by the National Scheme for Earthquake Recovery are rarely adjusted to local construction systems, especially as regards historic buildings and settlements Seismic safety marginal in various sectoral policies (concerning tourism, culture, transport, education, the environment etc.)	The institutional framework does not promote partnerships between the private sector (transport, tourism, construction) and the public sector Seismic safety not taken into account in various sectoral policies and agencies (concerning tourism, culture, transport, public works, the environment etc.) Not enough effort to build partnerships between the private sector (transport, tourism, construction) and the public sector	

Table B.1: Social factors influencing physical and social seismic vulnerability as deriving from the case of three islands in the Aegean

<table>
<tr><th colspan="4">Economic factor: Dependency on tourism</th></tr>
<tr><th colspan="2">Physical vulnerability</th><th colspan="2">Social and economic vulnerability</th></tr>
<tr><th>Impact on susceptibility to loss</th><th>Impact on recovery capacity</th><th>Impact on susceptibility to loss</th><th>Impact on recovery capacity</th></tr>
<tr>
<td colspan="2">Hazards and disasters have negative connotations thus they are rarely included in the considerations of the tourism sector

Policy choices: How seismic safety mainly concerning historic buildings and settlements can be included as an issue to the institutional framework for tourism?

Tourism can create huge pressures for fast production of building stock compromising seismic safety to the minimum standards set by the Codes. Moreover tourism may guide construction to unsafe soils such as the seaside and steep hills and lead to using old building stock such as historic buildings and settlements.

Policy choice: Regulation (planning, codes, standards etc.) versus market and growth- Interests (local, short term) versus the safety of tourists? How to raise awareness of tourists and make seismic safety a positive marketable quality? Regulating the tourist market as regards safety –EU intervention</td>
<td>Evacuation of tourists a huge difficult task.

Tourism can be sensitive to crises and disasters. A drop in business is expected at least for some time after the disaster.

Unemployment and loss of income in all sectors related to tourism (except construction)</td>
<td>Drop in tourism and related sectors hinders recovery (Possible outcomes: Migration, physiological and social problems)

Policy choices: - How to counterweigh limitations in resources and income from tourism. - Attracting tourism again ASAP after the disaster at the expense of EQ mitigation (Fast reconstruction versus seismic safety).

- Balance different sectors in reconstruction (tourism versus construction, tourism versus agriculture).

– Fast regaining of tourism may mean thus reproducing a dependency on tourism or introduction of changes

The hypothesis: DISASTER AS A WINDOW OF OPPORTUNITY</td>
</tr>
</table>

Economic factor: Regional disparities			
Physical vulnerability		**Social vulnerability**	
Impact on susceptibility to loss	**Impact on recovery capacity**	**Impact on susceptibility to loss**	**Impact on recovery capacity**
Areas of economic and social dynamism have a greater rate of building renewal thus newer and probably less vulnerable building stock and infrastructure. On the contrary vulnerability of buildings and lifelines is greater in the countryside where exposure is less. *Policy choice: How to balance seismic safety interventions between areas where the building stock and infrastructure are most vulnerable and areas where exposure is high* Historic buildings and settlements are more vulnerable as a rule. They are under preservation status in touristic areas or less developed areas. • *Policy choices: Put more buildings and settlements in preservation status in low growth areas or allow an easier and faster renewal of the building stock? How seismic safety concerning historic buildings and settlements can be included as an issue to the institutional framework for tour-*	Areas of low growth rate struggle to cope with repair and recovery of building stock. *Policy choice: State interventions (subsidy, loans, funding etc.) should be directed primarily towards areas in need or should be directed towards areas with dynamism?*	Differences in dynamism, human potential and available resources may result in a faster reconstruction of the developed areas leaving other areas even more behind. Thus a disaster may increase regional disparities. In such cases reconstruction may even seem successful if examined at the scale of the island, but it takes place at the expense of less developed insular areas. Depending on each case reconstruction makes winners and losers in terms of economic sectors, regions and social groups. There is no easy assessment of recovery capacity of each of these; however, reconstruction policies should target a holistic approach to the development of the disaster area and not limit themselves to the rehabilitation of buildings and lifelines.	

ism?		

Economic factor: Income inequalities			
Physical vulnerability		**Social vulnerability**	
Impact on susceptibility to loss	**Impact on recovery capacity**	**Impact on susceptibility to loss**	**Impact on recovery capacity**
Investment on seismic safety is of low priority for poor / low income groups copying in everyday life. Low income households rent cheaper places to live. Low market housing can be older or of lower quality and possible more vulnerable. Low income households live in many cases in the vicinity of dangerous / vulnerable facilities.	A disaster might worsen the economic situation of an already low income household, making difficult or impossible for it to spend on repairs. Low income households and renters tend to stay longer in temporary housing. Prices of repaired or reinforced buildings are higher, thus households that used them before the disaster might not be able to afford them after. Rent of repaired/reinforced/ retrofitted housing is higher and may not be affordable by low income households; thus they are pushed once again to use lower quality or even unsafe housing.	Low income households might have been struggling to cope even before the disaster. They suffer even more because of business interruption / disruption after the disaster.	Low income in many cases is associated with less qualifications thus possibly with less work opportunities in case of work shortage Recovery capacity depends of the sector of employment and on support networks. Changes in real estate after the disaster might change the human geography in the disaster area. Land and buildings change hands. Poorer households might be forced to abandon some areas and richer households break in new areas. Migration and/or urbanization may result from loss of home, job and work opportunities after the disaster. This applies more to lower income households especially if they have less attachment with the place.

Table B.2: Economic factors influencing physical and social seismic vulnerability as deriving from the case of 3 islands in the Aegean

Appendix III: Procedure of approval and force of new Italian building codes.

After 1984 classification of the national territory according to seismic criteria (following 1980 Irpinia earthquake), a new arrangement of the legal framework in the seismic field begins in 2003, few months after Umbria-Marche regions earthquake, by the promulgation of the ordinance 3274 of President of Council of Ministers – Department for Civil Protection (OPCM 3274) aimed at providing new technical rules for building in seismic areas and a new classification of the Italian territory. With such a legal measure, in fact, all the territory is recognised as "seismic" and a new class is added to the previous three for including all the municipalities excluded by the previous classification.

This ordinance, in line with Eurocode 8 grounded on seismic design of buildings, bridges and foundations, should have been in force in November, 2004, but a 6 months extension is announced in order to modify the text. In the meanwhile, the Minister of Infrastructure, declared the enactment of a comprehensive legal code entitled "Technical rules for constructions" (NTC) by June, 2005. Contextually, the efficacy of OPCM 3274 was shifted three months (2005, August) and then other two months (2005, October) in such a way to allow the enactment of the technical norms prepared by the Minister of Infrastructures.

The last ones, even if characterized by many points in contrast with EC8, have been published in the Official Journal (GU) in 2005 (D.M. 23 September 2005) with an expected validity since 2005 October. In detail, this date indicates the beginning of a period of transition during which it should be possible to make reference to the old technical rules too (D.M. 96); furthermore a devoted Commission was requested to monitor the new rules and to realize modifications and corrections. As the effectiveness of OPCM was further extended to October, 2005, although it was specifically born to reform seismic rules, the OPCM 3274 has never come in force but only advocated, by the NTC, as an optional method to design.

In the meanwhile, the provisional stage of NTC was extended to December 2007, but, in effect, such an extension should hev been functional to an organic re-examination of the norms in such a way to render them respectful of Eurocode 8 related to the structural design.

After one month of regulatory empty, a new ministerial decree, the DM 14 January 2008, including the NTC, is published in the Official Journal with validity from March, 2008. As a consequence, the 2005 NTC has never, as OPCM 3274, come in force after years of work.

Before March 2008, in a punctual manner, the conversion in law of a 2007 governmental decree established a new extension for the provisional stage of the new NTC (DM 2008) till June 2009,. In this period, it would be possible to apply NTC related to DM 14 January 2008, NTC related to 14 September 2005 or previous laws.

In an exhaustive manner, in February 2009, a new decree has established a new extension for the application of NTC till June 2010. In the meanwhile, a circular of the Ministry of Infrastructure (617/2009) devoted to give instruction for the applicability of the new norms, described the NTC 2008 as "the more advanced regulatory framework within the sector of construction, with coherence with Eurocode 8 and with respect to seismic building criteria". The last extension has been repealed in face of Abruzzo earthquake and finally the new NTC have come in force on 30th June 2009.