OD4.1

General framing document
for the development of a coherent portfolio of risk management approaches

THESEUS

Project Full title		Innovative technologies for safer European coasts in a changing climate	
Project Acronym		THESEUS	
Grant Agreement No.		244104	
Deliverable No.	O.D.4.1	Delivery Date	January 15, 2012
Deliverable Full title		General framing document for the development of a coherent portfolio of risk management approaches	
Work Package No. and Title		WP 4 : Impact mitigation: resilient societies and economies	
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Status (F: final; D: draft; RD: revised draft):		F	
Dissemination level: (PU = Public; PP = Restricted to other program participants;RE = Restricted to a group specified by the consortium; CO = Confidential, only for members of the consortium)		PU	
File Name		OD41_General_framing_document_FINAL	
Project website		www.theseusproject.eu	
Project start date and duration		01 December 2009, 48 month	

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PART I: Introduction

WP4 AND OD 4.1 AS IT APPEARS IN THESEUS' DOW

THESEUS' DOW page 7-8 states :

"The general aim of WP4 is to analyze and develop the contributions of social science and economics at addressing the challenges of transforming the concept of resilience into a portfolio of tested operational innovative tools for policy and management purposes of coastal flooding risks. More specific objectives are: to analyze the design of insurance scheme geared at contributing to coastal areas resilience (WT 4.1); to analyze how l land use planning can support coastal areas resilience (WT 4.2); to analyze and develop existing and potential business strategies geared at reducing the business sector need for coastal defence and their sensitivity to coastal flooding risks (WT 4.3); to develop protocols for the proper integration of post crisis response management (WT 4.4); to develop protocols for coastal flooding risk related research communication and use for risk governance (WT 4.5); to develop protocols for evacuation plans (WT 4.6). The objectives of WP 4 are measurable and verifiable as the WP can show steady progression from innovative concepts through the development of a general method for on-site surveys (see Milestone 4.1) to the analysis of results obtained by field activities in order to provide a tested portfolio of innovative tools for policy and management purposes (see Milestone 4.2). Throughout this process verifiable methodology for tuning on-site specifics tools for promotion of social and economic resilience will be documented."

Furthermore WP4 consists of the following work tasks: WT 4.1 Insurance programs; WT 4.2 Impact on urbanization and spatial planning; WT 4.3 Damage to businesses and rapidity of recovery; WT 4.4 Post-crisis response; WT 4.5 Risk communication and science for building resilience; WT 4.6 Evacuation plans.

COHERENCE BUILDING WITHIN WP4

In such a WP it was felt critical that the joining-up of WT based approaches transcends the sum of individual components. The present deliverable was thus conceived as the initial step to guarantee such a resilience building coherent portfolio of approaches.

In the course of the project's first eighteen months, the content of this deliverable was progressively defined through iteration between WP4 members and through presentation to the consortium as whole during meetings.

It was agreed the content of this deliverable will work at the dovetailing of WP4 various WTs through (1) operationalizing of the resilience concept, (2) taking into account the paradigmatic prejudice associated with WP5 and, (3) through a deeper work into transcending both approaches through their integration and through the definition of wider frameworks to be explored along the way articulating these around the concepts of social learning and epistemological distance taking.

STRUCTURE OF THIS DELIVERABLE

This deliverable begins with the present introduction as a reminder of the purpose of the work being presented. From this presentation elements are proposed in order to contribute as a first step to WP4 overall coherence It then carries on in section 2 by focusing on the operational resilience building as applicable to THESEUS' WP4 various tasks. This resilience framework allows for a second level coherence building. Section 3 focuses on the potential for WP4 to operationally feed the conceptual framework that is being used in WP5. In order to achieve this we analyze the various WT in terms of Source-Pathway-Receptor and Consequences as well as in terms of DSS contextualisation and framing. This S-P-R-C framework entails a third level of coherence building. Finally, we propose to use WP4 results to engage into the building of a framework that would allow focusing on the resiliency principles that would allow for positive transformation as opposed to the resiliency principles that focus on maintaining an original configuration. In every section we summarize the propositions for coherence building in separate Boxes. Six key recommendations for coherence building throughout WP4 can thus be identified

FLOODING, EROSION AND RISK GOVERNANCE WHERE DOES WP4 STANDS, WHERE DOES RISK GOVERNANCE STANDS WITHIN THESEUS[1]

RISK GOVERNANCE AND THESEUS

Risk governance is the application of governance principle to risk and risk related activities. Governance should be understood here as "structures and processes for collective decision making" and as such may involve the state, economic interests, civil society and academia, this at various institutional scales. At the core of the principle of governance lie the concepts of horizontal (i.e., between state, economic interests, civil society and academia) integration and vertical (i.e, between the local, regional, national and global scales) integration.

Risk governance is composed of five elements: pre-assessment, appraisal, characterization/evaluation, Management, and communication (Renn 2008). The first four elements are sequential and may be iterative, while the fifth element, communication, interacts with all (see Figure 1, below).

[1] Key contributors : Juan Baztan, Idrissa Kane, Nabil Touili and Jean-Paul Vanderlinden ; excepted when specified this section is rooted in Renn (2008).

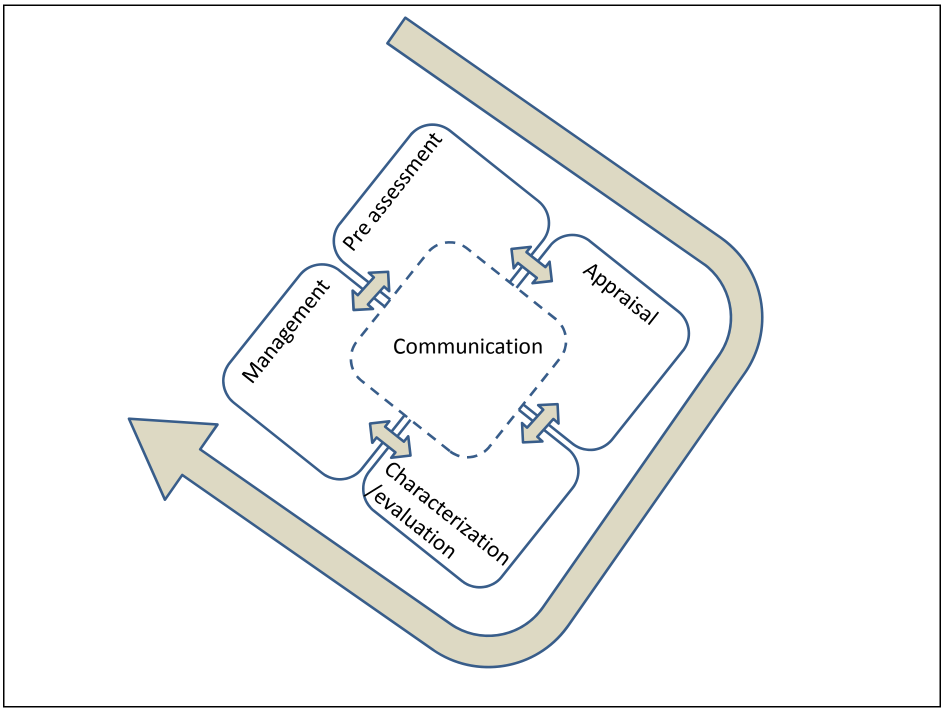

Figure 1: The five elements of risk governance (Adapted from ICRG, 2007, by and in Renn, 2008, p.48).

Within THESEUS, the overarching goal of "Safer European coasts" can generally be framed as a contribution to flooding and erosion risk governance principles. The structure of THESEUS and some of its founding principles (interdisciplinary research, multi-scale work, stakeholder participation in some work packages) are clearly aligned with governance principles of vertical and horizontal integration. Yet THESEUS has the particularity of being a science based and science centred project, articulating its activities within specific study sites. As such its activities will not necessarily cover all the elements of risk governance and will be dominated by a specific stakeholder group: members of academia.

Within WP4, the same characteristics apply. Yet the focus of WP 4 being social sciences, governance as an object of enquiry will be much more present. Here below we review some key characteristics of the various phases of risk governance.

THE PRE ASSESSMENT PHASE OF RISK GOVERNANCE

Pre assessment is composed of four key elements:

1. Problem framing,
2. Early warning,
3. Screening, and
4. Establishing scientific conventions for risk assessment and concern assessment.

Within THESEUS scientific conventions have mostly been established in THESEUS' DOW relying on the extensive experience and expertise of THESEUS' consortium members. Within THESEUS as well the Screening has been partly defined ex ante (i.e. flooding and erosion risks have been chosen as pertinent risk to address in order to contribute to safer European coasts) and is partly, but to a much lesser extent, dovetailed within the first four WP. Early warning, understood here as the systematic search for new hazards, is integrated into WP1.

Finally, the framing of THESEUS' risk management contribution lies at the core of WT1.7, in which most of the WP4 participants are involved. Results from WT1.7 have shown that there is within THESEUS' high probabilities of dissent both

- in terms of risk selection rules (i.e., members of the consortium and members of affected communities may not have the same risk selection rules, the latter putting a more important weight on ethical issues), and
- in terms of relevance of evidence (i.e., members of the consortium and members of affected communities may not rely on the same information, the latter putting a more important weight personal and collective heuristics).

This has potential implications for WP4, and is therefore proposed as part of the overarching framework that is presented here.

Within WP4's WTs it may be worthwhile to relay any dissonance between members of THESEUS' consortium and research subjects in the study sites regarding: coastal risk selection rule and the assessment of the relevance of the evidence that are being used. This should allow for an iterative feed of WP4 to other WPs with a focus on WP5.

Box 1: First recommendation regarding the development of WP4 overarching framework, identifying dissonance between science-based knowledge and local heuristics.

THE APPRAISAL PHASE OF RISK GOVERNANCE

Risk appraisal consists of two major components:

1. The scientific assessment of risk to human and nature, and
2. The scientific assessment of related concerns.

A carefully conducted risk appraisal will produce high quality (best available?) scientific estimate of the physical, environmental, social and economic impacts of a risk source. Appraisal is thus often divided into two distinct phases: risk assessment and concern assessment.

Risk assessment consists broadly of three elements: hazard estimation, exposure and/or vulnerability assessment and, estimation of risk, combining likelihood and severity of consequences in physical terms. Risk concerns assessment consists, six factors are generally identified in the “risk concerns” sphere (see THESUS’ ID 1.5 for a detailed discussion): (1) perception of familiarity with the hazard, (2) understanding of the hazard and its connection to consequences, (3) risk effects on equity, (4) perception of fear and dread associated with the hazard, (5) perceptions of control over the risk and, (6) degrtee of trust in risk management organizations.

In THESEUS the appraisal phase is the major undertaking of WP1.

A critical dimension of risk appraisal lies in its scientific nature. Yet appraisal will be used for the purpose of managing a particular risk which entails social and political support for the management option that will be chosen. This support will be based on a different knowledge base, originating from personal and collective heuristics. It is therefore highly desirable that the appraisal be somehow integrated to the personal and collective heuristics of those that will be impacted by risk and its management (see THESEUS’ ID1.5 for empirical validation and discussion of this). This leads us to formulate a second coherence building proposition.

Whenever possible new knowledge generation within WP4 could, through deliberative participation of study site stakeholders, be integrated to their personal and collective heuristics.

Box 2: second recommendation regarding the development of WP4 overarching framework, integrating science based appraisal with local heuristics through deliberative participatory research processes.

The risk characterization and evaluation phase

Risk characterization consists of establishing the risk profile, judging the seriousness of the risk under scrutiny, and establishing the need for risk reduction. This characterization is partly established in the site analysis conducted in the course of the project preparation and is thus included in the DOW, yet most of this work is being established through study site application of the progresses made in WP1.

Risk evaluation consists in establishing the level of a specific risk’s acceptability/tolerability, and in establishing the need for risk reduction measures. Again this phase, in THESEUS, is the product of study site level work for WP1.

THE RISK MANAGEMENT PHASE OF RISK GOVERNANCE.

Risk management consists of the major components decision making and implementation. Due to the nature of THESEUS' as whole and due to nature of WP4 we focus here on decision making.

Decision making lays obviously at the core of THESEUS various contributions. The innovative nature of THESEUS lies mostly in its commitment to generating new risk mitigation options, be it engineering options in WP2, ecosystem based options in WP3 or socio-economic based in WP4. The assessment of these innovative options is integral part of the relevant WPs. The second key innovative development of TESEUS lies in the integration of the options and the application of truly integrated multi criteria Decision Support System that includes option assessment.

This integrated approach to option generation poses a key challenge for WP4, challenge that leads to a third coherence building recommendation.

The analysis of the management options generated through WP4 should be focused on the potential synergies between options. The integration of various options should clearly provide benefits that are greater than the sum of their individual benefits.

Box 3: third recommendation regarding the development of WP4 overarching framework, maximizing potential synergies between WP4 mitigation options.

THE COMMUNICATIVE DIMENSION OF RISK GOVERNANCE

This dimension is the focus of WT 4.5. The critical component here is to remind oneself that communication must be present at all phases of risk governance.

PART II: The governance based mitigation options in THESEUS

INNOVATIVE INSURANCE SCHEME AS A MITIGATION OPTION[2]

LITERATURE REVIEW

INTRODUCTION

Natural hazards and disasters refer to generally violent or unexpected environmental phenomena which may cause significant loss of life and serious economic, environmental and social impacts that greatly affect the wellbeing of a society. United Nations define specific criteria that have to be fulfilled in order to consider an event as a natural disaster. The inclusion of an event as a disaster requires the occurrence of one of the following: 10 people or more have to be reported killed or 100 people reported affected or local authorities to make a call for international assistance or to declare a state of emergency (UN-ISDR).

There are two broad categories of natural disasters. Climatic disasters that result from atmospheric phenomena such as global warming, floods, hurricanes and droughts and geological disasters that occur as a result of geological changes, such as earthquakes and volcanoes. The Indian Ocean tsunami in late 2004, hurricane Katrina that hit New Orleans and the Gulf Coast in August 2005, the earthquake in Haiti in January 2010, the torrential rains in northeastern Australia in December 2010 and the earthquake in Japan in March 2011 are some of the most recent and striking natural disasters that the world has experienced.

The severity of the consequences depends heavily on the structure of the economy that they hit. In the industrialized countries, it is most probable to have losses to capital stock, while losses of life are usually avoided because there are effective forecasting and warning systems. On the other hand, in the case of the developing countries, natural disasters are more probable to result in heavy loss of life because there are no organization, prevention and evacuation systems. Most empirical studies find a negative relationship between development level and disaster losses (Albala-Bertrand, 1993; Kahn, 2005, Anbarci et al., 2005; Toya and Skidmore, 2005). The higher the development level, the smaller the damages and losses those respective countries will suffer. However, with the increasing complexity of society and interdependency within and across countries, the recent studies show that the total impact per capita has an inverted "U" curve relationship (Figure 2 below) (Benson and Clay 1998; Lester, 2008; Kellenberg and Mobarak, 2008). The reason is that least developed countries tend to have simple economic structures, such as agriculture, so that the impact may not spread to the entire system while higher-income level countries have sufficient financial and technological tools to perform an efficient program of prevention or recovering from a natural disaster. However, as GDP per capita increases, the complexity of economic system also increases and as a result the disaster impacts have a positive

[2] Section authors: Phoebe Koundouri, Mavra Stithou, Athen University of Economics and Business, Benedicte Rulleau Université de Versailles Saint Quentin en Yvelines

correlation with GDP per capita up to a certain level before decreasing. Hence, in this context middle-income level economies might be the mostly affected.

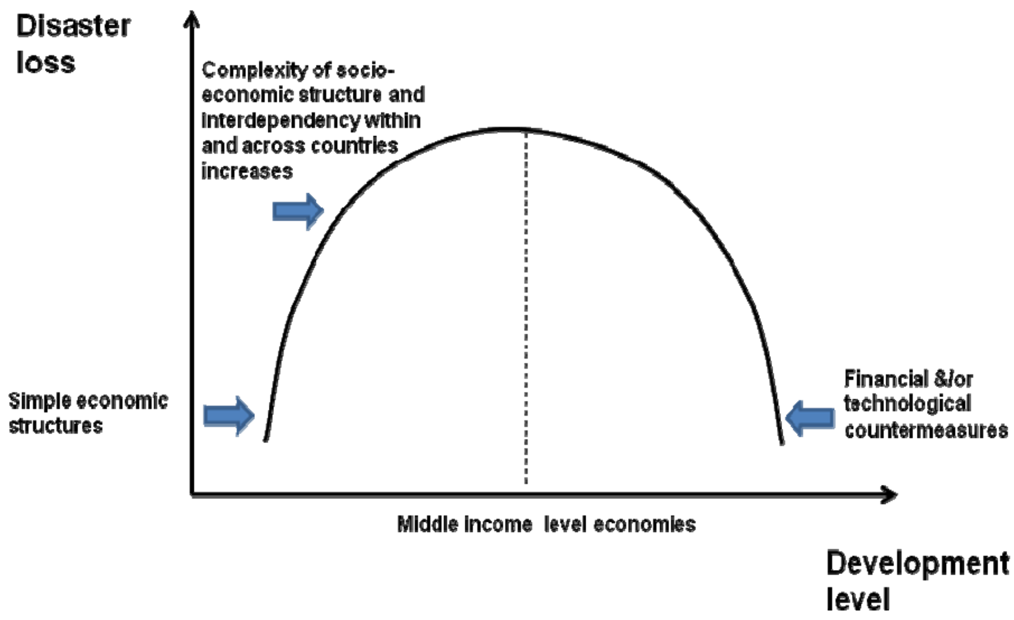

Figure 2: Inverted "U" curve relationship between disaster loss and development level.

In this context, in order to face the challenges of natural disasters and in particular of flooding in relation to climate change, a range of flood risk management measures of structural and non-structural character exist. These measures as reported in the recent literature are presented in the following section with an emphasis on the contribution of insurance market.

The role of insurance schemes to coastal flood risk management

In order to explore the role and effectiveness of measures to offset risk related to flooding and shoreline erosion it is important to define it. Risk of flooding in European water management is defined as a function of the probability of a flood event and its potential effect (expected damage in terms of monetary damage and human causalities) (Rijkswaterstaat, 2005).

Coastal flood risk = P flooding x E (D)

As it is reported in the following Figures (3, 4) there are different ways to deal with flood risk that can be categorised in two main groups. On the one hand, we observe structural measures (engineering constructions, e.g. dykes, barriers etc. or run-off reduction and storage interventions) that aim to reduce flood hazard and the probability of flooding and on the other hand, non-structural measures (land-use planning, insurance schemes etc.) that aim to reduce flood vulnerability.

Summary of flood risk management measures.

Intervention	Effect of action	Potential modification of risk calculation (Eq. (2))
Climate change mitigation	Mitigation of greenhouse gases will lead to less significant changes in the climate.	Different climate change mitigation strategies are considered through alteration of the probability of a given loading through time.
River and coastal engineering measures	Hard engineering measures (e.g. river conveyance, defences, and engineered storage) reduce the probability of flooding by providing more efficient mechanisms of removing water from the system, or increasing the capacity to withhold greater quantities of water. 'Soft' engineering measures (e.g. beach nourishment and vegetation management) reduce the vulnerability of defences through dissipation of energy.	The effectiveness of flood defences may be considered through appropriate alteration of the probability of flooding at the time they are implemented.
Rural runoff reduction and storage	Reduce flood severity from altered runoff properties through changing the infiltration, storage and conveyancing properties of catchments and floodplains.	Alters the probability of flooding.
Urban runoff reduction and storage	Reduce the probability of flooding using a combination of storage, infiltration, conveyancing and drainage capacity management.	Alters the probability of flooding.
Flood incident management	Flood-forecasting and warning systems provide information to flood risk managers, local authorities and emergency services which is subsequently disseminated to the public in order to sufficient time that they can take effective mitigative actions before the flood arrives. Proactive pre-incident activities ensure that the public, emergency services and other key stakeholders are well prepared and able to act sensibly, and understand information on flood warnings, during and just before the flood.	Most flood incident measures act to change the depth-damage relationship of floods (if followed by appropriate action by the public) and increase public safety and reduced health impacts of flooding. However, some flood-fighting actions (e.g. reinforcing failing defences) can reduce the probability of flooding and their success is tied to timely responses to specific flood events.
Flood-proofing	Reduce flood damage.	Flood-proofing measures change the depth-damage relationship for the properties in which they are implemented. These could be retrofitted to old properties or designed into new builds.
Land-use planning	Limit construction of buildings and infrastructure in the flood plain, hence controlled increase in vulnerability.	Land-use planning measures change the overall damage function through time by altering the rate of floodplain development.
Building codes	Reduced flood damage. In new buildings it is possible to implement flood proofing measures that are more reliable than retrofitted properties. For example, raising buildings on stilts.	Flood-proofing measures change the depth-damage relationship for newly built properties in which they are implemented.
Risk spreading (e.g. insurance)	Redistribution of the cost of damage across the population and through time.	As well as redistributing risk, insurance is a potent means of communicating flood risk through an economic signal so it can change the overall damage function through time by providing a mechanism for discouraging development in high risk areas.
Health and social measures	Reduced social, health and associated economic impacts of flooding.	Health and social measures could be incorporated if an appropriate health/social, or secondary economic impact damage function was available.

Figure 3: Summary of flood risk management measures (Source Dawson et al., 2011-in press).

Hence, as it is demonstrated in Figures 3 and 4, insurance market is one of these non-structural measures that can contribute to flood risk management. The contribution of insurance in flood risk management can be multi-dimensional in a sense that it can: transfer risk, enhance risk awareness, and contribute to the reduction of flood vulnerability and support the rebound of socio-economic systems. Therefore, the role of insurance is of critical importance to the manager and to society (Clark 1998). These points will become even clearer when the reaction of insurance market to natural hazards will be explained in later sections.

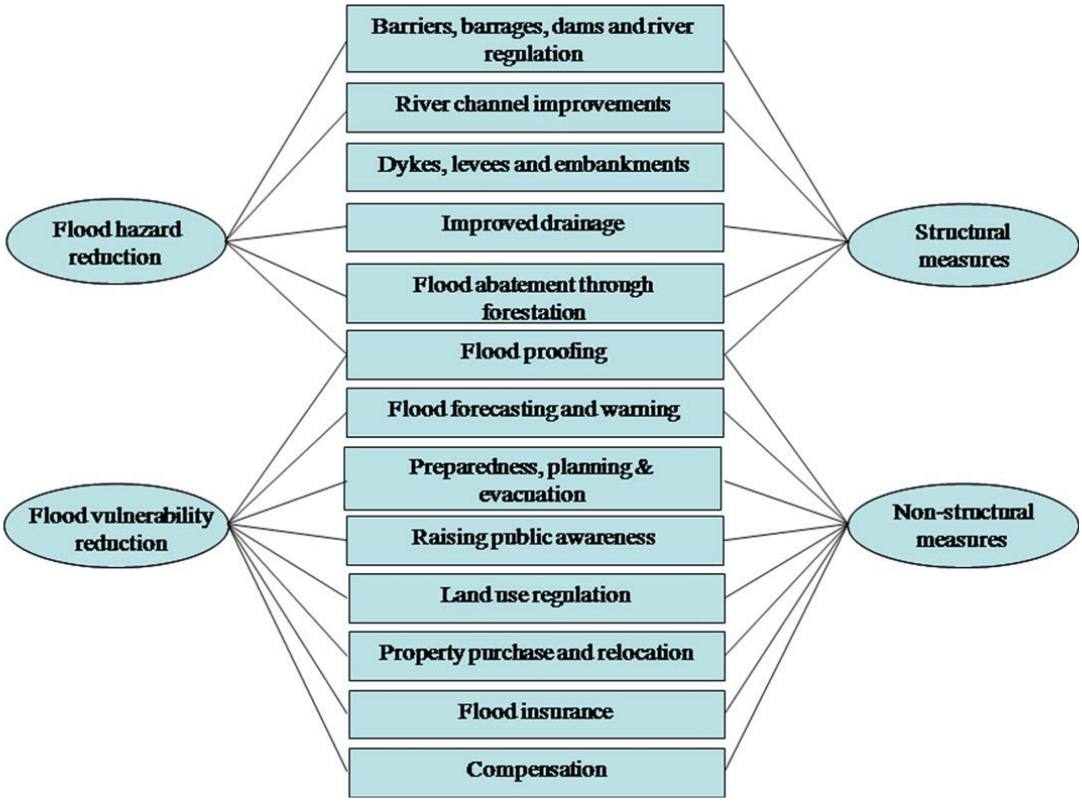

Figure 4: A categorisation of flood risk management measures into structural and non-structural (Source Parker (2007): cited in Harries and Penning-Rowsell, 2011).

Flood insurance could be analysed by considering the Risk Triangle of the Figure 5 herebelow. As presented in the figure below risk encompasses a combination of hazard, exposure and vulnerability.

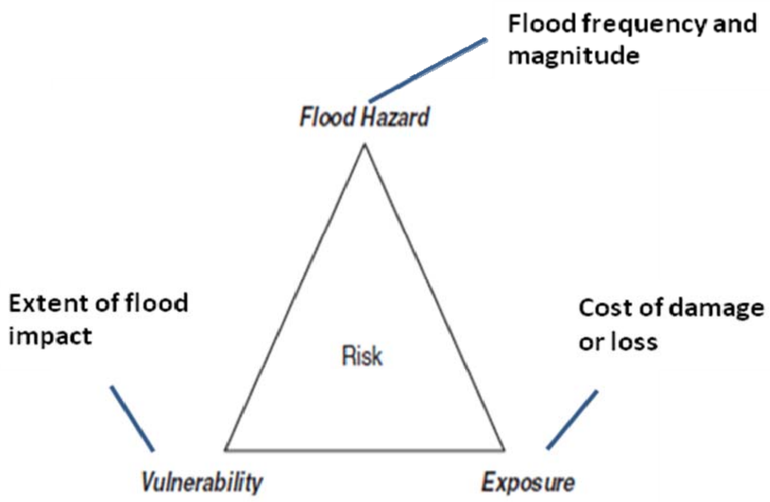

Figure 5: The Risk Triangle (Source Crichton and Mounsey, 1997).

As it has been stressed out: “this figure has being particularly appropriate for the (flood insurance) industry as it articulates ‘risk’ as being the area of the triangle, the sides of which represent hazard, vulnerability and exposure. It hence suggests that if any one element increases/decreases then the related side of the triangle, area of the triangle and hence the amount of risk will increase/decrease accordingly” (Crichton, 2001, p. 352). Clark (1998) points out that insurers can impact on vulnerability and exposure by introducing conditions on the available coverage and by modifying the insurance excesses/deductable or removal of property.

Crichton and Mounsey (1997), offering this insurance industry perspective, argue that the hazard is the probable frequency and severity of the peril occurring in a particular geographical area, and thus relates to the natural process (flood) frequency and magnitude. As the authors emphasise although hazard cannot directly be managed by insurers, it can be at a greater or less extent predicted and managed by sea defence activities. As vulnerability indicates the extent to which a given hazard would impact on a property by reason of its materials or its layout, it is regarded that insurance can impact on vulnerability by introducing a condition on cover (e.g. keeping valuable items above flood level, constructing flood proofed buildings). In addition, as vulnerability is related to location, insurers invest on institutional attempts to restrict development in hazard zones. The other dimension of risk, exposure, is a function of the value of the asset/property at risk translated in cost of damage or loss. As authors stress out exposure is modified by insurance excesses or removal of property to a safe location on receipt of a flood warning.

As pointed out previously, the insurance has an important social contribution in promoting resilience in the aftermath of disaster however, such promotion is relative rather than absolute (Clark, 1998). Hence, it should be acknowledged that there are mechanisms other than insurance for feeding post-disaster relief into a region - including institutional aid and extended family support. However, there is a more important contribution. As emphasised by Clark (1998): “in terms of coastal zone management, insurance has another potential role which assists recovery by minimizing death, loss and damage in the first place, by focusing attention on risk (the extent and cost of available cover indicates a professional assessment of risk), and by placing the burden of that risk on the hazard zone dwellers (actuarially-effective premiums, possibly linked specifically to flood, remove liability from non-floodplain dwellers)” (p.333). Insurance reduces vulnerabitility and sensitivity by affecting “perceived risk”. In this way risk flooding is reduced and hence resilience under uncertainty, due to socio-economic and climate change, is promoted.

Market incentives, as Natsios (1991 cited in Treby et al., 2006, p.356) suggests, are possibly the most effective way of changing social behaviour. Thus, flood insurers could play a critical role in risk reduction and avoidance (mitigation) via the use of financial (dis)incentives:

- Lower deductibles, i.e. lower premiums for properties that take action to reduce their exposure to flood risk, e.g. flood-proofing.
- Bonuses for non-claims.
- Premium pricing related to risk—placing the onus on the client to assess their reaction to the known risk as highlighted by premiums that are high or indeed lacking.
- Resilient re-instatement. i.e. reconstruction undertaken as a result of insurance payouts that aims to reduce the risk of future losses (Arnell, 2000).
- Compensation and re-housing in an area of lower flood risk. However, for this (and the previous) strategy to be adopted would require a degree of government intervention.

Hence, insurance can be seen as a catastrophe recovery (promoting socio-economic resilience), cost limitation and management tool (Clark, 1998) by sharing risk, influencing decisions to locate in the floodplain and by encouraging the use of measures to minimise damage (Doornkamp, 1995; Arnell, 2000).

However, at this point it should be also noted that insurance’s development and effectiveness is conditional on social, economic, physical and other factors.

An example of the relationship between state and insurance industry is provided by Sturm and Oh (2010). The authors taking the case of Hurricane Katrina stress out that although raising premiums following a high-loss year is probably the simplest and most obvious response to high reinsurance rates for primary insurers, in order to do so, insurers must first apply for such increases to regulators in every state in which they want to raise premiums. On the other hand, being international business entities with no set geographical and financial centres, reinsurers are more flexible since they are not subject to the same forms of government regulations.

The authors regard that the impact of government regulations can be negative even if successful applications for rate increases have been accomplished, if state regulators continue to maintain premiums caps that remain well below what insurance companies need to charge based on their actuarial calculations. That was the case in States after Katrina leaving insurers little financial reason to offer coverage and causing the exodus of primary insurers from risky markets. Hence, it has been expressed the view that regulations and subsidies need to be lifted so that insurers can charge premiums that give the right signal of actual risk of living in a particular area. In that way it will not be necessary for insurers to raise their rates in lower-risk states.

Drawing conclusions from the UK experience Harries and Penning-Rowsell (2011) demonstrate that the development and effectiveness of insurance market or of other non-structural measures is related to the degree of exposure of decision-makers to the victims of the hazards and hence to the emotional involvement with flood victims. More importantly authors argue that it is cultures and rationalities that have become embedded within organisations tasked with managing societal exposure to environmental risks as a result of previous, more narrowly defined, policies according to which structural, engineered approaches were the norm. This latter attitude is that limits the ability of society to respond flexibly and with fairness to climate change.

Harries and Penning-Rowsell (2011) state that: "the institutional bias towards engineered measures, as opposed to behavioural approaches, is legitimised and reinforced by decision-makers' exposure to the most vociferous proponents of that approach – the most badly affected and most vociferous victims of adverse environmental events" (p. 196). Furthermore, this bias towards structural measures was enhanced by UK Government. As the authors state a high-profile agreement between the government and the Association of British Insurers (ABI) asserts that ABI members will continue to offer insurance to high-risk households only if the Environment Agency instigates ''greater investment in defences". Furthemore, ABI members promise to offer cover to new customers only if their home is not at ''significant risk'' of flooding. Hence, institutional and cultural barriers put the emphasis on flood defences and in this context risk is defined in terms of probability while reduction of vulnerability is not a priority.

TYPES OF FLOOD INSURANCE

We could identify three main types of insurance schemes related to flooding. Private insurance, public insurance and mixed. Private insurance is related more to resilience building and is characterised as simple recursive. On the other hand, public insurance deals with the diffusion impact of natural disasters such as flooding which is deeply uncertain since it is not very clear how long the boundaries of the impact are.

The Insurance Information Institute (III) provides an overview of flood coverage in USA and other countries. According to III: “there are two basic methods of providing flood insurance in developed countries. Under the first, the optional system, insurers extend their standard policy to include supplemental coverage for flood damage on payment of additional premium. The coverage tends to be expensive due to the fact that only those most likely to be flooded, and therefore to file claims, purchase it, a situation known in the insurance industry as adverse selection. Among the countries with optional coverage are Germany, Italy and the Netherlands. The other method is “bundling.” Under this system, flood coverage is combined with coverage for other perils such as fire and windstorm, thus spreading the risk of flood losses across a large geographical area and greatly increasing the percentage of the population covered for flood damage. Countries that have adopted this method include the UK, Spain and Japan. In addition, in some countries such as France and Spain there are government compensation programs for major disasters, including flooding, that take effect when the cost of a disaster reaches a certain level. The system in the United States is unique in that the government underwrites the coverage and private insurers act as administrators bearing no actual flood risk” .

The following figure (6) presents different approaches to flood insurance that can be considered along two axes: the degree of bundling and the level of state support.

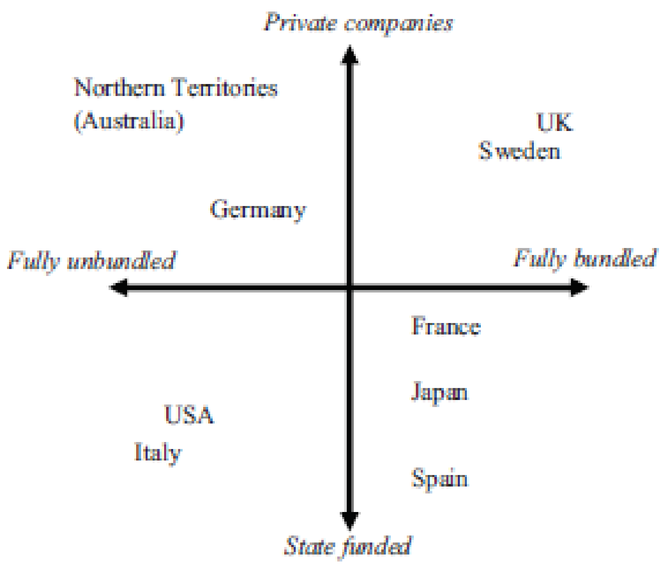

Figure 6: Different countries have different home insurance markets where insurance can come bundled with all cover (including flooding), or unbundled (where each component is sold separately) whilst the market may be entirely private, or a state monopoly (Dawson et al., 2011).

As the authors note unbundling is common in insurance markets with some companies to specialise in offering specific insurance for risks considered too high by others. Furthermore, within a single company, the pricing of policies and setting of excess/deductible values may vary.

On the other hand, national systems of flood insurance also vary considerably in respect of the type and degree of government intervention. Hence, in the USA the Federal Emergency Management Agency (FEMA) allows property owners in partici- pating communities to purchase flood insurance as a protection against flood losses as long as the state and local community implement floodplain management regulations, while in many European countries the government is the insurer of last resort, but there is a great variety of approaches. For example, there may be the case of no insurance at all (as in the Netherlands), through state-sponsored and mediated insurance systems with varying degrees of private sector involvement: for example, France, Germany and Spain, to the fully private UK mode.

Commenting on the debate between state or private insurance Sturm and Oh (2010) are referred to the events after Katrina. What happened is that when federal reinsurance was proposed Munich Re disagreed with it, insisting instead that there is a distinct role for the government outside of offering insurance. In particular, it was argued that: “the state’s main efforts should focus on risk management and reduction by designing and enforcing land use and building regulations, developing emergency plans and coordination of authorities and agencies involved in post-disaster response, regulating insurance company behaviour and so forth. One of the main problems with government insurance plans is that they add another dimension of control to industry practices and, more importantly, they tend to follow public sentiments rather than rigorous risk analyses, thereby pricing themselves into debt” Sturm and Oh (2010, p.159). As Anselm Smolka, Head of Munich Re’s GeoRisks department, writes, ‘‘the state has to act as a reinsurer of last resort or for very rare, extraordinary losses and/or uninsurable risks that exceed the capacity of the private sector” (Smolka 2006, p. 2153, cited in Sturm and Oh, 2010). Sturm and Oh (2010) argue that the aversion to create a state-sponsored reinsurance scheme can be also explained by the fact that insurers and reinsurers would prefer to allow market forces, rather than public sentiment, to determine who should bear the most risk.

From the above it is concluded that not only is natural perils insurance in its own right a key to coastal zone socio-economic resilience (social and economic recover ability) by claim payments but it also indirectly promotes risk minimization by planning disincentive provided by insurance withdrawal (e.g. redlining). However, as Clark (1998, p.343) argues: “that insurance can survive as a management support to coastal resilience only if governments, scientists and insurers combine to manage the natural risks without removing them. But the only certainty is that insurance demands uncertainty, and though the situation is currently under control the pressure continues to mount for even more concerted response”.

CONSEQUENCES OF NATURAL DISASTERS

As noted before the severity of consequences of natural disasters depends on the structure of the economy, while the concept of vulnerability is of paramount importance when exploring consequences. It is regarded that losses of a natural disaster such as flooding and expected damages are dependent on vulnerability. As it has been reported: “vulnerability is conditioned by both biophysical and social conditions, including topography, poverty, access to information and insurance, gender, and ethnicity, and involves both external structural factors and individual capacity to cope with extreme events”

(Liverman, 2001, p. 4657). As a result, it is acknowledged that there is a distribution of sensitivity and resilience to hazards across geographic space, and between social sectors that should be taken into consideration by policy-makers.

Therefore, it has been noted that "hazard management has shifted away from physical processes alone and has, in turn, embraced its socio-economic, political and behavioural underpinnings" (Treby et al., 2006, p.352). Hence, according to authors risk of flooding can be seen to be associated not only to natural physical hazard but also to the socio-economic vulnerability of the affected population (Treby et al., 2006) as depicted in Figure 7 below.

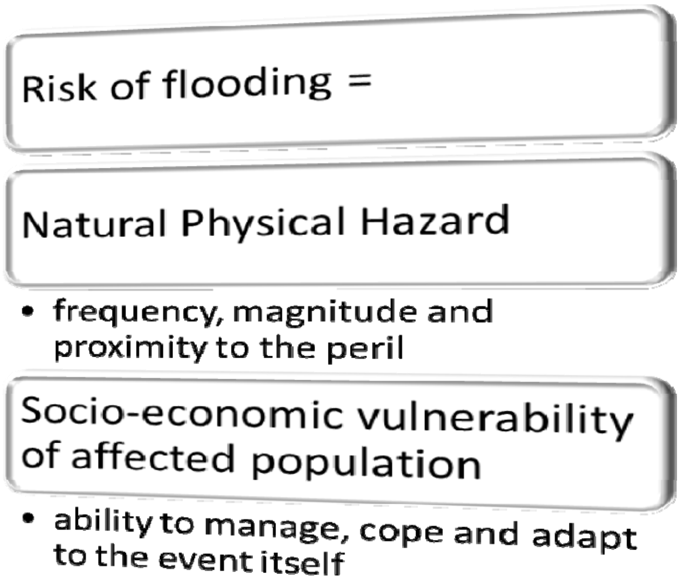

Figure 7: Risk of flooding.

In this context, acknowledging the role of insurance in reducing vulnerability and exposure, as presented in the previous section, the link between insurance, vulnerability and consequences of flooding becomes more apparent. In addition, if the importance is also put on reducing not only flood loss reduction but also loss susceptibilities [exposure] and vulnerabilities a more effective and efficient floodplain management could be achieved. However, as Treby et al. (2006) note, it should be also recognised that this is not only personal responsibility, but also responsibility of other parties (government's current planning policy and practice, insurers).

Focusing on consequences per se, it is obvious that the most severe impact of a catastrophic event is the loss of human life. In the case of natural disasters, there are a number of factors that can reduce the death toll, but the unexpected character of these events can lead to a large number of losses. Hurricane Katrina for example, counting only for Louisiana, resulted in an estimated number of 1,577 casualties.

According to general labor market estimates of the value of statistical life, these lives are valued at $7 million per fatality therefore resulting to an economic cost of $11 billion (Viscusi, 2006). This value does not represent the total cost of natural disasters since we need to take into account all the generated negative impacts.

It should be also noted that the loss of human life, health impacts, historical and cultural losses constitute social losses of intangible character. Another intangible loss is that associated to environment and in particular damages to ecosystem and ecosystem services, for example due to flooding. Losses are characterized as tangible or intangible depending on the possibility of assessing them directly in monetary terms.

At this point it could be argued that insurance could play a role as a market mechanism in capturing intangible losses at some extent. For example, insurance (more likely private) related to human life or health provides an assessment of monetary character. For intangible losses of public character such as cultural, historical it is more likely insurance to be of public character or mixed. Hence, insurance seen as a defensive expenditure mechanism can provide an insight to intangible losses.

Following the suggestions of the United Nations we can classify the effects of natural disasters into three categories (ECLAC, 2003). Direct damages refer to effects on property, indirect damages to effects on goods and services production flows and secondary effects which refer to the impacts of the catastrophic events on the main macroeconomic factors. It is custom to refer to the above classes of impacts as damages, first-order effects and higher order effects respectively. Direct effects coincide with the damages that occur within hours of the disaster, while the other two effects practically affect the social and economic life in a period of as much as five years.

In more detail, direct damages are classified as all damages in assets and inventories which include every physical infrastructure, buildings, installations, machinery, equipment, transportation means and storage and furniture, and damage to cropland, irrigation works and dams. The destruction of these assets might be total or partial and accordingly the cost of the directed damages will be estimated. Furthermore, it is custom to include in the estimation of the direct damages cost, the estimated cost of demolishing and clearing areas where there has been destruction.

Indirect effects refer to the flows of goods and services that cease to be provided during a period of time beginning almost immediately after the disaster and possibly extending for significant time afterwards (up to five years), although the greatest losses are most probable to occur in the first two years. Indirect damage is caused by the direct damage to the production capacity and social and economic infrastructure, and the loss of flows due to business interruptions, such as production and/or consumption. It should be noted that direct and indirect losses form part of the tangible losses.

In this context, if we consider the case of flood impacts tangible measurement of primary direct impacts will include damage to buildings and infrastructure and intangible measurement of the same category of impacts may include loss of natural capital and ecosystem functions or loss of an archaeological site. In the case of indirect impacts, disruption to transportation will be a tangible measurement of primary indirect impact and loss of industrial production/trade will be a tangible measurement of secondary indirect impact. As a far intangible measurements of indirect impacts are concerned these could include inconvenience of post-flood recovery. As it will be explored in more detail in a following section (Section below) indirect flood impacts include also modifications in insurance policies and management of risk in a more sustainable and efficient way.

Finally, secondary effects count for the disaster's impact on the main macroeconomic variables. They measure the disaster's effects on the functioning of the economy and they cannot be added to direct and indirect damages without causing duplication and this is why we do not add them all together. One important issue when we discuss the impact on the evolution of macroeconomic variables is that it is important to have a sense about the behaviour of the variables if the disaster did not happen in order to account for the country's ability to proceed with the rehabilitation and reconstruction phases. The variables of main interest are the gross domestic product, the balance of trade, the level of indebtedness and of foreign reserves and on public finances and gross investment. Additionally, studies also focus on the secondary effects on inflation, employment levels and household incomes.

RESPONSE OF PEOPLE, FIRMS, INSURANCE COMPANIES AND GOVERNMENT TO NATURAL DISASTERS

PEOPLE'S RESPONSE

Geography, sociology and anthropology have contributed considerably to hazard research. In particular, geographer Gilbert White set out to understand the processes by which humans become exposed to natural hazards, such as floods, and the role that human adjustments may have in reducing hazard losses. Furthermore, sociology theories of collective behaviour and social organization contributed to understand response to disasters (Quarantelli, 1978), while anthropology highlighted the significance of indigenous knowledge and cultural traditions in attitudes and responses to hazards and risks in several regions of the world (Douglas and Wildavsky 1982).

Several approaches provide an insight on how people perceive risk and hence react towards it. In an activity where participants were asked to rate different factors/dimensions of risk on a five-point scale, the list produced the following important factors affecting natural hazard risk perception: voluntariness, reducibility of risk, knowledge and experience, endangerment, subjective damage rating and subjective recurrence frequency (Plattner, Plapp, and Hebel 2006: cited in Morrow, 2009). Hence, the extent to which hazard is considered a threat that needs actions depends on a host of factors that influence outrage (emotions), such as whether exposure is voluntary, equitably distributed, can be controlled, is familiar, is dreaded and is diffused over time and space. Morrow (2009) reports four steps that are involved in the process of making decisions: (i) perceiving the situations, (ii) considering possible courses of actions, (iii) calculating which is in your best interest and (iv) taking actions. When analyzed through the very specific lens of economics, there is a variety of models that try to explain risk decisions, namely the expected value approach, the expected utility theory, the prospect theory and the conjoint expected risk.

People can take precaution measures to protect their life and assets from natural risks in a number of ways. Although unexpected, natural disasters have some patterns which make them somehow predictable. This fact gives the opportunity to individuals to move out from areas that are at high risk and reallocate in a safer area. In addition people can choose to self – protect by building structures less vulnerable to damage. Finally they can insure, that is, pay a premium in an insurance company, which in case of a natural disaster they will receive, compensation.

Decisions on whether they will get some protection or on the type of protection that they choose are highly diffused among individuals since they depend on a plethora of factors that affect human behaviour. Therefore the consequences of a natural disaster will vary between individuals with different characteristics. Apart from the economic status, crucial role in the decision making regarding how people will respond to natural hazards play personal experience. People who have suffered a disaster tend to be more willing to adapt precautionary measures. In the same direction moves "availability heuristic", that is how a specific and unknown hazard brings familiar images in the mind. As a result, socioeconomic and personality characteristics of individuals as well as knowledge and experience of previous events can influence views and adjustments to hazards such as flood (Kates, 1962).

For example there is evidence that income characteristics and creditable institutions can influence the severity of the outcomes from disasters (Kahn, 2005). In addition, literature suggests that people with lower socioeconomic status tend to face greater financial impacts when they are victims of a disaster (Blaikie et al., 1994; Dwyer et al 2004). Although, households of lower income may spend less money than a wealthier household, they are likely to spend a higher proportion of their income on recovery and therefore suffer a more significant financial loss. Another result reports the tendency of lower income households to move into damaged areas after the occurrence of a natural disaster since the heavy damaged areas are characterized by low rents. On the other hand, middle income households that can afford to move out, usually choose to make a new beginning in a less vulnerable area. Finally, higher income households tend to make no changes since their affordability allows them to take the necessary measures and protect themselves from future similar risks. Finally, similar to the previous results households on lower incomes are also less likely to have purchased insurance against natural hazards (Tooth and Barker 2007). Similar studies demonstrate the same features when we consider the response of firms to natural risks. In conclusion, we can say that natural disasters have a greater impact on lower income groups.

Focusing on the experience of flood insurance in States in '90s, where most individuals in high-prone areas do not purchase coverage voluntarily Kunreuther and White (1994) hightlight some principal reasons that could explain this behaviour. Among these are that individual underestimate the probability of a future disaster if they have not personally experienced the event, view such expenditures as poor investments if they have not made a claim on their policy in previous years and calculation of benefits is based on very short time horizons so that the cost of investment appears large relative to the returns that are calculated over just the next year or two.

Dawson et al. (2011) comment on the fact of under-insurance in flood risk areas, showing that household's response is also conditional on different factors. Explanations include that people may ignore, knowingly or not, low probability but high consequence events. On the other hand, others may be aware but are priced out of the insurance market by high premiums or deductibles or the risk is underestimated because of overconfidence in 'hard' measures such as dikes. However, as expected a recent flood experience appears to be an important criterion in the purchase of flood insurance (Browne and Hoyt, 2000, cited in Dawson et al. 2011). Ofcourse, as authors point out the existence of an insurance market and the offer of insurance from all potential provides are critical factors for householders' ability to obtain cover.

Finally, considering the individual level of response conditional on insurance coverage, it is interesting to look at the results of Botzen's et al. (2009) study. In particular, the authors examine the willingness of homeowners in the Netherlands to undertake measures that mitigate flood damage in exchange for benefits on hypothetical flood insurance policies by using surveys. The results indicate that many homeowners are willing to make investments in mitigation, while reductions in (absolute) flood risk due to mitigation are especially large under climate change.

A probit model indicates that existing arrangements for compensating flood damage (the role of government), risk awareness and perceptions, and geographical characteristics are more important determinants in the decision to undertake mitigation than the socioeconomic characteristics. It is noteworthy that the main incentive for homeowners to choose for investing in water barriers is likely to be the premium discount on the flood insurance policy provided to them in the survey.

"The current institutional setting characterized by availability of partly compensation of flood damage by the government reduces private incentives to undertake mitigation. Second, perceptions of risk and climate change play an important role in the decision to undertake mitigation. In particular, the higher the risk of flooding is perceived the more likely are homeowners to invest in water barriers. From these results follows that homeowners may be stimulated to undertake mitigation investments by abolishing the current scheme of government compensation and raising awareness of flood risk. The second finding suggests that provision of information about changing climate risks could through perception influence the mitigation behaviour of homeowners. Third, geographical characteristics, like elevation of the house, distance to a main river and living in a rural area, determine the decision to invest in mitigation." (Botzen et al., 2009, p. 2275).

Firms' response

In general terms, when reviewing the impact of natural disasters on businesses what are mostly considered are: human resources, physical resources, business continuity and Disaster Recovery Plan (DRP). Business Continuity Planning (BCP)/DRP is a way an organization can prepare for and aid in disaster recovery in order to expedite the recovery of its critical functions and manpower. In particular, it is an arrangement agreed upon in advance by management and key personnel of the steps that will be taken to help the organization recover should any type of disaster occur.

Following Clemo (2008), the insurance industry helps ease the burden on customers affected by weather events such as floods by:

- Managing the repair process.
- Bringing in supplies and quality assured repairers, even if local suppliers are overwhelmed.
- Providing for temporary accommodation while repairs are undertaken.
- Business Continuity Planning: If taken out as part of the cover, the insurance company in question will provide alternative premises for small business to run out of while repairs are in progress and appropriate resources to go with that as needed.

Although, focusing on industries that deal with hazardous systems Paté-cornell (1996) identified two options for these firms that can be combined in a global risk management strategy: insurance (loss sharing) or to actually reduce the expected losses of time unit through preventive or mitigation measures that depend on the nature of the risks involved. The second option of risk mitigation includes technical and organizational measures.

Empirical data on business behaviour facing natural disasters risks are limited (Dahlhamer and Tierney, 1996; Alesch et al., 1993; Kroll et al. 1991). Dahlhamer, J. M., and Tierney (1996) explored the distributive effects of disaster on 1110 Los Angeles area firms impacted by the 1994 Northridge earthquake. A questionnaire survey was employed to collect the data and regression techniques were used to analysis them. The model used to predict winners and losers was based on an earlier analysis of business recovery following the earthquake. Findings showed that business size, financial condition, disruption of business operations, earthquake shaking intensity, and the utilization of post-disaster aid were significant predictors of being worse off 18 months after the earthquake. In particular:

Small size, a business characteristic, was a significant predictor of being worse off, relative to being about the same. The authors argued that size helps insulate firms not only from other sudden perturbations in their environments, such as interruption in the flow of supplies or sudden market downturns, but also from disaster impacts. Furthermore, businesses in good/excellent financial condition prior to the earthquake were significantly less likely to be worse off, as opposed to being about the same, than firms in poor financial condition. Businesses in good financial condition have the resources necessary to invest in measures to mitigate disaster-related damage. Disruption of business operations and earthquake shaking intensity were equally important for understanding recovery outcomes. The more problems the earthquake caused businesses and business owners, for example, by disrupting customer traffic or making it difficult to ship and receive goods, the more likely they were to be worse off following the earthquake. This finding suggested the importance of moving away from narrow definitions of disaster that only take into account factors like direct physical damage. In addition, businesses located in high shaking intensity zones had higher probabilities of being worse off after the earthquake because, in addition to experiencing damage and disruption themselves, they also had to deal with neighbouring pockets of residential and commercial damage.

In addition, firms that used post-disaster assistance were significantly more likely to be worse off following the earthquake than firms using no aid. This finding is inconsistent with the literature on household recovery, which finds that the more aid a household uses, the better its chance for recovery. The authors cited three possible explanations:

Businesses had to be very badly off before they sought aid following the earthquake. Second, since grants to firms are virtually nonexistent and few businesses have earthquake or other types of disaster insurance those that formally seek outside funds generally must rely on governmental or bank loans to cover disaster-related losses. Loans, however, bring with them additional indebtedness. Third, it is also possible that the assistance received was insufficient or even businesses who receive sufficient aid may suffer because their neighbours have not reopened or are not doing well.

Finally, only financial condition was a significant predictor of being better off. Unexpectedly, firms in financial trouble prior to the earthquake were significantly more likely to be better off after the earthquake than firms in good financial condition. More likely, the relationship was shaped by the kinds of businesses that had been struggling before the earthquake (e.g. construction firms).

Another finding of the study was that only 20.5 percent of the firms in the sample (1110 firms) reported having earthquake insurance at the time of the disaster, and, of those, only 28.0 percent filed an insurance claim after the earthquake. Overall, only 5.5 percent of the firms in the total sample used earthquake insurance to cover disaster-related losses.

Alesch et al. (1993) study on firms located on earthquake-prone areas in Unites States revealed that relatively few small businesses had insurance unless they were required to purchase coverage in order to secure a loan. This behaviour was mostly explained by the “it will not happen to me” belief. Alesch et al. (1993) also traced the vulnerability of small firms to their low cash reserves and the difficulty they had undertaking preparedness and mitigation measures. Smaller firms affected by the earthquake suffered proportionally greater losses than larger ones, and larger companies quickly implemented strategies for recovery following the disaster because they had planned to do so in advance (Kroll et al., 1991). Kroll et al. (1991) also found that small firms and businesses in the trade and services sectors were severely disrupted following the 1989 Loma Prieta earthquake, while business improved for firms in the construction sector.

Crichton (2006) reported that research in August 2006 had shown that 90 per cent of small and medium enterprises in UK (SMEs) were under-insured, with 70 per cent of businesses in high-risk areas not being concerned that flooding would affect them. Also in 2006, while 85 per cent of businesses were aware that climate change is an increasing problem for the world, 46 per cent of SMEs thought that climate change was blown out of proportion and only 26 per cent thought that it is a real threat to them. Clemo (2008) argued that the small-scale nature of these businesses often means that they are ill-equipped to deal with their business premises being flooded, and this is especially the case for businesses such as hotels, bars and restaurants, which have no way of continuing their business in the event of a flood.

An interesting finding regarding response to natural disasters and in particular to flooding is observed in States after the 1993 flood. In some areas of St. Louis region "instead of shrinking from hazardous locations, individuals got right back to work rebuilding what was undertaken with enthusiasm. Sometimes, but not always, the flood led individuals and businesses to adopt some mitigating activities with the rebuilding. For example, one business owner in Chesterfield Valley located all the computers on the second floor of the office after the flood, leaving the first floor for expendable items, while others decided to purchase flood insurance. At the time of the flood, about one-third of the firms in the floodplain were renters, most of whom left the Valley, while the two-thirds who owned their property for the most part rebuilt" (Kousky and Kunreuther, 2009, p.17). Hence, there may be the case that floodplain residents take in rebuilding after a disaster resulting in the reconstruction of repetitive loss properties.

An insight on the response of firms to natural disasters is also offered from the literature related to farmers' decision-making in the absence of insurance markets. That is, from producers' production side when facing production uncertainty and incomplete information, Koundouri's et al. (2006) findings showed that the probability of adopting an efficient technology increases for farmers who experience higher variance of profit and for farmers that face the risk of extreme values of profit. The empirical results suggested that farmers are willing to adopt in order to hedge against production risk, while improvements in farm's human capital (i.e., education level, extension services, farming information accumulation) generally increase the probability that the farmer adopts the new irrigation technology. It should be noted that there is a considerable number of studies that have also empirically investigated technology adoption by taking into account farmer's perception about the degree of risk concerning future yield (Tsur et al., 1990; Saha et al., 1994). Furthermore, there is a strand of literature that investigates the role of crop species diversity as a risk off-setting mechanism through its effect on the mean and variance of agricultural yields (Di Falco and Chavas, 2006; Di Falco et al. 2007; Smale et al. 1998, 2003; Widawsky and Rozelle, 1998) and through its effect on the mean and variance of farm income (Di Falco and Perrings, 2003, 2005). Particularly, farmers' attitude on choosing crop combinations is related to their tolerance of risk. Other important findings from this literature is that there are heterogeneous risk preferences among farmers (Koundouri et al., 2009), while policy instruments can affect farmers' revenue in terms of both production and insurance behavior (Koundouri and Nauges, 2005).

Finally, it should be noted that, as it will be presented in Annex II, qualitative surveys on case studies areas within THESEUS framework will provide more information regarding firms' response and behaviour towards natural disasters. In particular, employed questions aim to gauge firms' knowledge, perception and attitude related to insurance schemes.

MARKET RESPONSE, WITH THE EMPHASIS ON INSURANCE COMPANIES

Evidence of market responses to disasters is provided by Smith et al. (2006) and Born and Viscusi (2006) focusing on the housing market and insurance market responses respectively. Smith et al. (2006) examined housing decisions in the Dade County, Florida area using data from the U.S. Census in 1990 and 2000. Thus, they were able to analyze a before-and-after snapshot of the housing market in that particular county, and assess the extent to which the intervening hurricane influenced housing market decisions. Findings show that following Hurricane Andrew, low-income persons moved into the damaged, high-risk areas of the county. Such migration is not surprising as damaged areas will have lower property values and will be more affordable to those with lower income. However, as Viscusi and Zeckhauser (2006) noted there will be less public support for a subsequent bailout of damaged high-risk areas should a hurricane strike again. As far as middle income households are concerned they abandoned their residential areas after the hurricane inflicted substantial damage, following standard economic predictions. On the contrary, the very wealthy households tended to stay put, which the authors suggest may be due to a greater ability to self-insure or to invest in self-protection. Finally, the authors conclude that behavioural adaptations involve a complicated mix of relocation decisions, self-insurance decisions, and self-protection decisions.

Important results in the literature focus on the impact of natural disasters on insurance companies. When a natural disaster occurs, insurance companies active in the disaster area suffer great losses from paying compensates. The characteristic of catastrophic losses for an insurer is that they do not tend to follow a predictable pattern across time; instead they tend to occur in random periods with diffuse total cost of damages. On the other hand, it has been expressed the opinion that for insurance companies, providing widespread coverage, even in the most hazard-prone areas, has proven profitable for two reasons: first, hazards are spatially imprecise and second, they occur relatively infrequently (Sturm and Oh 2010).

These features give rise to specific behaviour structures for insurance companies. The size of losses may lead to a situation where the insurer may not have sufficient resources to cover them and relief the insured victims. Therefore firms may go bankrupt or suffer significant reduction in their earnings. Also it is possible that some firms will select to exit a specific area which will be considered of high natural risks to avoid future exposure to similar losses. This will also influence local economy since efficiency in insurance markets will decrease due to the reduced competition.

Another impact of catastrophic losses in insurance markets is the increase in the rates charged by the insurers. The firms that remain are exposed to the possibility of a reoccurrence of the disaster leading them again to great losses. This is why, after paying the disaster reliefs to insurants, the insurers will probably decide to charge higher premiums in the years where there are no catastrophes to ensure profitability.

A third characteristic of the insurance companies linked to natural disasters is the adaptation of the observable patterns of natural disasters in their operational decisions. A variety of factors can lead insurers to update their insurance policies for specific areas or time periods. Global warming nowadays is expected to cause more unexpected extreme weather phenomena; the melting of the poles increases the danger of floods in beachside areas. This information should be taken into account by rational insurers.

Born and Viscusi (2006) in their study on the effect of disasters on insurance companies reported that during the year of the unexpected catastrophes (blockbuster catastrophes) such as Hurricane Katrina, the level of insured losses rises, as does the loss ratio, which is the ratio of losses incurred to the value of premiums earned. However, in the period following a major catastrophe, the loss ratio is below its historical level. That is because firms raise their premium rates so that the invested premiums during the years in which there is not a blockbuster catastrophe will be available to address the losses when a particularly catastrophic event does occur. Furthermore, as the authors noted a blockbuster catastrophe increases probability of a firm’s exit from the state, and hence the firms that remain tend to have a very large stake in the insurance market in that state. Furthermore, it has been observed that catastrophe led to a reduction in the number of firms that are willing to write insurance in a particular state and in the number of customers willing to pay for higher premiums (Born and Viscusi, 2006).

Sturm and Oh (2010) comment also on the case of Hurricane Katrina and the response of insurance industry to the increased incidence of disasters in highly-insured regions of the world. As authors demonstrate with claims reaching into the billions of dollars, the reinsurance industry itself has raised premiums, spread risk farther afield, and jumped scale by spreading risk to futures markets called Alternative Risk Transfers (ARTs).

Authors present how the competitive strategies of the insurance industry have changed and how the industry responded to the costs of the 2004, 2005, and 2006 hurricane seasons. Analysis reveals that it altered its competitive strategy through geographic withdrawal, increase in premia, and the entrance of new providers. They note that the industry potentially possesses a built-in resilience through its risk-spreading arrangements (in part ARTs) and a large capital base (often provided through the reinsurance industry) that allows it to effectively approach and respond to catastrophic loss events like Hurricane Katrina.

Although the randomness of hazards allows insurance companies to generate profits and pay for insured claims, it can also undermine their capital reserves. Most large insurance companies are able to cover damages using their own reserves; but, in extreme cases, reinsurers and capital markets help to fund claims payouts.

As authors emphasise an important characteristic of insurance is that it seems, has the ability to overcome problems of scale that render states both cumbersome on the local level and powerless on the international level, as insurance and reinsurance companies have the ability to link the global with the local through risk-sharing agreements that connect bilateral agreements between policyholders and providers to a vast array of corporations, investors and clients.

Sturm and Oh (2010) focus on the case of Atlantic hurricane season of 2004 to explore insurance response and confirm that raising premiums following a high-loss year is probably the simplest and most obvious response to high reinsurance rates for primary insurers. However, the effect is that just as reinsurance rates climbed around the world, insurance premiums rose dramatically throughout the United States and were not limited to those living and conducting business in the Gulf States, as insurers sought to offset the higher cost of reinsurance.

The result of this response was that while “increasing premiums helped to generate capital, spread risks and more accurately reflect the cost of coastal living (and elsewhere) in the United States, there was a mixed response from primary insurers insofar as deciding when the risks of operating in a particular region became too costly. The list of insurers who have pulled out of markets in the Gulf States is long, nearly all of whom have left due to high reinsurance costs and economically infeasible hurricane risks in the region.” (p. 157).

Another impact was that the state’s largest insurer, Citizens’ Property Insurance (a state funded company), ran a $1.6 billion deficit in 2005 as the company was forced to absorb many customers that were dropped by fleeing insurers, although it is very rare for an insurance provider to drop existing customers.

The exodus of primary insurers from these risky markets can largely be explained by the fact that, despite the successful applications for rate increases, state regulators continued to maintain premiums caps that remained well below what insurance companies needed to charge based on their actuarial calculations leaving insurers little financial reason to offer coverage (Kunreuther and Pauly, 2006).

There have been also cases that many insurance companies refused to offer flood insurance in certain flood-prone areas. In this situation a publicly funded national insurance plan has been put forward. In this way the government share some of the burden of risk and offer some assistance to homeowners and the remaining insurers in the region.

As it has been reported in Harries and Pennings-Rowsell (2011, p.195): “The experience of single, less extreme, events has little effect on the representation of nature and can result in increased popular pressure for more measures to reduce event probability, making it harder for decision-makers to include vulnerability reduction in the range of risk management measures”. Therefore, large shocks that increase in frequency would expect to drive insurance schemes and flood management in general to mitigation measures and reduction of vulnerability.

There is no doubt that in such an uncertain environment the research department of insurance and reinsurance companies has a very important role to play as its contribution is to examine the impact of different events on the insurers’ profitability, solvency, and performance under different scenarios regarding future losses. Hence, apart from solvency, insurers must guarantee that there is adequate demand for their policies. Consequently, they must monitor the premium rate, the deductible level and the insurance cap level. It should not be underestimated that insurance discourages investment in security if insurers face moral hazard problems due to their inability to detect careless behaviour on the part of the insured agents. If moral hazard problems can be eliminated through the terms of the contract (e.g. deductibles, coinsurance) and/or through monitoring and inspection, then insurance with actually fair premiums encourages a risk averse individual or firm operating in isolation to adopt protection whenever the cost of the measure is less than the reduction in the expected losses .

In order to make sure that insurance markets can better absorb catastrophe losses and also provide affordable insurance, innovative approaches have been developed to structuring risk sharing. Hence, it has been observed the establishment of public-private or national-international partnerships in order for local insurance companies to cope with huge losses. Furthermore, advancements in global financial and insurance/reinsurance markets have increased the ability to spread weather risks across countries. As a result new instruments, as mentioned before, such as catastrophe bonds and weather insurance contracts (i.e. ARTs) have a considerable potential for local insurers and governments. Hence, it should be also acknowledged that governments and bilateral/multilateral financial institutions can contribute to the development of sustainable structures. The advantage of these novel methods of increasing capacity and protecting businesses from catastrophic losses apart from reducing the price of reinsurance through sharing risk among a pool of international investors is that it is geographically flexible (Sturm and Oh, 2010). ARTs emerged in the late 1990s in response to declining profits and increasing costs of catastrophic losses and catastrophe bonds (or ‘‘cat bonds”) are the most commonly-issued type of ART.

In particular, “cat-bonds” work by transferring a specified set of risks from an insurance company to a group of international investors. A set of trigger conditions are tied to the issuing of the bond and if the conditions are met, then the investors lose all or part of their principal; however, if by a certain date the conditions have not been met, then investors receive a massive payout. The advantages of “cat-bonds” are that they offer greater financial capacity, funds can be released more quickly, bonds can be locked down for several years, and they serve to reduce the price of reinsurance since financial risk is shared among a large pool of investors (Sturm and Oh 2010). However, on the other hand there is general agreement among insurers and reinsurers alike that ARTs do not have the built-in financial resilience of reinsurance since investors tend to be fickle. The authors stress out that lack of transparency, baseless actuarial risk calculation, and lack of accounting transparency are possible dangers of ARTs.

Bougen (2003, p. 260) argues that there is an acceleration towards non-insurability to the point that today ‘‘reinsurers catastrophes can either remain or become re-insurable only if innovative solutions or more imaginatively assembled risk networks for catastrophe financing can be discovered”. The insurance industry’s jump to the scale of derivatives markets is one such innovative aspect of risk society. As Sturm and Oh (2010) note industry’s power lies in its ability to transfer and distribute risk among various state and non-state actors from the local to the global. The industry is also significant in that it accounts for an incredible amount of financial activity in the global economy.

In particular, Sturm and Oh (2010) try to define the appropriate scale of insurance to function. Authors argue that there is no appropriate scale at which insurance should operate. “Rather the system is structured in a series of fall backs related to the level of risk, where urban disaster-related events are both geographically and temporally incalculable therefore limiting actuarial calculations. Large-scale ARTs might best fit for hurricanes but may not be financially viable for regional river flooding or other less costly events. The point is that the scale is geographically contingent on the region in question. Furthermore, the industry is in constant flux adopting new competitive strategies that favour certain scales over others depending on the context. What is clear is that ARTs are a last resort for the insurance industry.” (Sturm and Oh 2010, p. 161).

A particular challenge for insurance companies in the light of climate change is how to deal with a situation where key epistemological dimension of climate change lies in its “never happened before” dimension.

As it has been commented also in the report Adaptation Lessons from Past Experience (African Development Bank et al., 2003, p.23) that: “An important challenge to developing weather insurance of this kind is the availability of reliable and verifiable data on weather patterns. Weather stations with appropriate hardware systems need to be put in place to ensure reliable readings on insured events. However, weather events can also vary spatially, so the existence of microclimates and localized disasters needs to be taken into account. In some cases, weather events show a trend. ... Hence, while insurance schemes can help to spread the risk of climate impacts, their limitations need to be carefully considered, particularly because climate change may cause changes in climate variability and the occurrence of extreme events in a region, and past experiences may not apply to the future”.

At this stage of global climate change, Mills presents two options for the insurers: ‘‘[insurers] may rise to the occasion and become more proactive players in improving the science and crafting responses. Or, they may retreat from oncoming risks, thereby shifting a greater burden to governments and individuals” (Mills, 2005, p. 1043).

Furth more, ARTs appear to be the result of the inability of the reinsurance industry to know by actuarial calculation what their exposure to risk is as in the case of climate change. As Sturm and Oh (2010) note, in some ways, ARTs are the insurance industry’s attempt to capture the ambiguities of risk, geography, and time in an extra-territorial scale and in this context they can be conceived as the best defence against actuarial uncertainty related to disasters. Authors also note that increased global warming disaster potentials mean higher-priced disaster recovery that conventional insurance cannot afford, hence ARTs, along with the state as the last backstop, may be the best defence in the near future.

Following Clark (1998) uncertainty has traditionally been a part of the insurance equation, and as flood data and prediction increase in precision the relationship between risk and insurance alters fundamentally. In an insurance framework hazards are indentified from historical records and predictive models and as such insurance industry is a key player in risk evaluation. In particular, its role is dual both undertaking and sponsoring research to improve the historical record, the physical model and the predictive capability in order to improve the actuarial basis for pricing and managing the natural perils market (Clark, 1998). As it has been reported: "Average damage, hazard band location of insured property combine to predict the extent of the company's exposure to claims, and can then guide the setting of appropriate premiums. It is then possible to assess the company's capacity, and thus identify the level of additional capacity and catastrophe support that needs to be purchased from reinsurers - a judgement with enormously important commercial implications" (Clark, 1998, p. 337). However, making such calculations more sensitive and more robust is challenging both in principle and in practice.

In an effort to achieve more precision and accuracy in prediction application of high resolution photogrammetry from air photography is rapidly becoming technically feasible and economically viable while related satellite-based remote sensing approaches are also applied. However, as Clark notes (page 341) "If individual (property) hazard is known with great precision in space and time, low risks will become apparent and although some insurers may be tempted to 'cherry pick' these attractive clients they will increasingly withdraw themselves from insurance cover, thus reducing the loss-bearing potential of premiums from outside the risk zone.".. "Conversely, particularly high risk properties revealed by high resolution data could in the future be targeted by the insurers for premium increases or even withdrawal of cover - and they may also be forced out of the market, further reducing its viability".

As Clark (1998) further observes, long-term environmental change such as climate change and short-term variation in the intervention of socio-economic systems in physical systems (i.e. coastal defence) both confound the attempt to find simple predictive models. Hence, in this context the perception of the hazard may be misleading. According to the author the implications are detrimental to both the insured and the insurer: underestimation of hazard exposes the company to future heavy burdens of unexpected claims, while overestimation of hazard and vulnerability is equally damaging to commercial effectiveness in that it leads to excessive laying off of exposure onto reinsurers or ultimately progressive withdrawal from potentially profitable business.

Reinsurance companies focus also in identifying emerging risks – risks which have so far been totally or uninsurable or only partially insurable because the requisite mechanisms and solutions have not yet been exhaustively researched. Research and Development Department of Munich Reinsurance (Munich Re) , in Munich, Germany encourages the development and application of methods that allow risks to be recognised at an early stage and quantified. Different disciplines such as modelling of complex risks, behavioural economics, and the modelling of the human factor in risk management are joined together for this purpose. Munich Re set up the Emerging Risks Think Tank, a small group of employees from different areas. The group develops scenarios for situations that had appeared inconceivable up to now. The think tank was made up of underwriters, lawyers, geologists, sociologists, mathematicians, physicists and medical doctors. As emerging risks researcher Rainer Sachs states "Risks are becoming ever more complex and our challenge is to understand the various interactions between risks. In order to develop solutions for our clients, we have to take an interdisciplinary approach. We bring together experts from different areas and describe a risk landscape which so far had not been mapped out."

Many risks are captured in the database and the interactions so well researched that causal chains can be presented in a database. The Munich Re World Map of Natural Hazards has been a valuable source of information for risk management professionals since it was first published in 1978. “If emerging risks were understood as deeply as possible, further questions emerge in relation to our business: What needs will the risks trigger among insureds and what kinds of risk coverage can be developed in response? And on this basis, concrete solutions can be developed for our clients”, says Sachs.

Munich Re states that attaches importance to research and development in order to constantly analyze known risks for significant changes in their structure or occurrence probability and to identify new risks at an early stage, while the innovative insurance solutions enable clients to make sustainable investments. Munich Re closely monitors the constantly changing and increasingly complex parameters. For example, in the field of reinsurance the Special Enterprise Risks unit investigates alterations in the transfer needs of clients and uses the findings to develop new products, while in primary insurance and in Munich Health, the emphasis lies on analyzing and forecasting demographic trends.

Another major global reinsurance company is Swiss Reinsurance . As claimed in its Annual Report 2009, Swiss Re collaboration with scientists to quantify the effects of climate change on coastal flood damage extents company’s expertise in measuring loss. The company emphasizes the systematic approach to identify and analyze risks, development of new risk-transfer solutions with international financial institutions so as to make societies more resilient, pioneering for developing new approaches for disaster risk financing such as public-private partnership based solutions, and promoting the concept of country risk management. Exchange ideas and insights through strategic partnership, membership in international organizations and links to academia are highly valued in order to share expertise and learn more about risk.

Company claims that models are no substitute for the collective judgement of the senior management team. Therefore their usage has to be a matter of internal governance, in which the executive management or the Board should become more involved. The governance structure will need to assure that risk models are designed and calibrated independently of the risk-taking function, that they are subject to independent expert review and that the processes are subject to adequate control to ensure the models are applied correctly. The company manages its risk through the Risk Management that aims to ensure an appropriate risk-reward balance in all of the Group's risk taking activities. Dedicated specialised units within the independent Risk Management division monitor the Group's risk-taking activities, while Risk transparency, knowledge-sharing and responsiveness to change are integral to company’s risk control process.

The recent literature in economics suggests that risk aversion and ambiguity aversion characterises insurance firms’ decision processes and strategies (Mayers and Smith, 1982; Kunreuther et al., 1993). Kunreuther (2001) noted that insurers are concerned with the possibility of insolvency. Recent developments in information technology and the emergence of new capital market instruments to deal with non-diversifiable catastrophic risks open up opportunities for residents and firms to undertake cost-effective loss protection measures and provide a financial cushion to insurers. The author emphasises that risk transfer mechanisms, underwriting strategies and mitigation measures enable an insurer to survive financially in case of a catastrophic loss. In particular, risk transfer mechanisms include indemnity contract to cover losses above a certain amount or an indexed catastrophe linked bond to obtain needed funds should a severe disaster occur, underwriting strategies include raise deductible levels, set a cap on the maximum insured value, selectively choose which risks to include in issuing policies and mitigation measures can include building code, land use diversification etc.

From the above we conclude that a common strategy of insurance companies in the face of natural disasters is to increase premiums or pull out of risky markets. A cyclical pattern of premiums is also observed from insurers and reinsurers who after an increase of premiums to build up capital, often reduce rates following years of few claims (Sturm and Oh, 2010). Linking premiums to mitigation measures and building public-private or national-international partnerships are two other responses to cope with the hazard. In addition, ARTs in global markets (e.g. catastrophe bonds and weather insurance contracts) are proved to be alternative strategies considering the randomness in space and time of natural hazards. Sturm and Oh (2010) comment that "the fact that hurricanes repeatedly struck one area in the world did not seem to hurt the industry to a great extent can be explained by the competitive strategies at several geographical scales of policyholders, reinsurers, investment portfolios and, more recently, ARTs." (p.161). Finally, investment in R&D is of paramount importance in order to explore changes of known risk and identify new.

GOVERNMENT'S RESPONSE

The response of governments to natural disasters and their intervention is of considerable importance since when we are dealing with natural disasters we are talking about events with significant public good characteristics and significant external effects. As Sturm and Oh (2010) note the fact that a large scale natural disaster triggers higher cost of premiums, this has as an effect to exclude those lower-income communities often most affected by large-scale disasters. Hence, from this perspective, the restructuring will inevitably leave millions of individuals without or with geographically inadequate property insurance either forcing them to move from, or endure the pain of destroyed, property, memories, culture, and community. Traditionally such effects are difficult to handle in private markets as private markets are not equipped in dealing with externalities and public good characteristics. As a result, this calls for public intervention. In addition, the government in its traditional role as publics' good provider must decide about the level of protection to provide to an area. It should be also reminded that the magnitude of loss is influenced to a substantial degree not only by individuals' exposure to the hazard and the level of personal self-protective behavior but also from government's policy. Of course the formation of this public intervention should be adapted to the needs and characteristics and adaptive capacity of the private sector.

In general terms, public intervention is necessary before and after the event of a natural disaster. Government's efforts have an important role to play before and after such an event and the scale of intervention is also conditional on the existence or not of an insurance market or on how competitive such a market is. Kunreuther and Pauly (2006) noted that the lack of interest in insurance protection and mitigation by property owners and by public sector agencies prior to a disaster often creates major problems following a catastrophic event for victims and the government. In such a case, the role of public intervention is important especially as a legislative authority in order to establish an ex ante public program (e.g. mandatory private disaster insurance or building codes in disaster prone areas) that can be proved more efficient than ex post public disaster relief program.

Kunreuther and Heal (2003) noted that government intervention may be deemed important when the evaluation of adopting a specific mitigation measure by the public is underestimated. The authors emphasized the need for well-enforced regulations in case of negative externalities to various parties by citing the example of a building that collapses. This event may create externalities in the form of economic dislocations and other social costs that are beyond the economic losses suffered by the owners. These may not be taken into account when the owners or developers evaluate the importance of adopting a specific mitigation measure. One way for the government to enforce its regulations is to turn to the private sector for assistance. More specifically, third party inspections coupled with insurance protection can encourage divisions in firms to reduce their risks from accidents and disasters. Hence, that authors argued that in the framework of a management-based regulatory strategy decision-making is shifted from the regulator to firms who are now required to do their own planning in order to meet a set of standards or regulations.

Another point raised from the USA paradigm is that "private sector insurers and reinsurers cannot carry the burden of environmental hazards which regularly occur in the same area, and in these cases it becomes increasingly necessary for governments to play a role, perhaps by providing the ultimate safety net of emergency relief and disaster aid if not taking the step of subsidizing insurance" (Clark 1998, p. 341)....It must be recognized, however, that utilizing government as insurer of last resort could be regarded as more attractive in areas of very high catastrophe potential (such as the USA) than in areas (such as the UK) where total risk is still within the ability of a viable commercial insurance market to cover."

As already mentioned, natural hazards tend to be highly publicized. This means that when they occur, they usually affect a large proportion of the society including individuals, firms and governments. The behaviour and the response of these groups, depends on how they assess the probability of natural hazards, what is their estimation for the expected total cost and their ability to protect or recover from an unexpected disaster as the disaster will affect various parts of the community in different ways.

Apart from insurance companies, governments will also absorb a large proportion of the cost following a disaster. The question of interest is whether there exist effective mechanisms for spreading the cost beyond those immediately affected. The typical classification of measures to be undertaken by local authorities includes three phases:

a) Emergency phase;

b) Rehabilitation and recovery phase, also called the transitional phase; and

c) Reconstruction phase.

The emergency phase takes place immediately after the disaster and aims in saving life. It includes searching and rescuing, evacuation, building of shelters, providing first aid, emergency relief and medical assistance and trying to restore transport and communications networks. The second phase begins when the emergency phase is completed. The rehabilitation or transitional phase covers all activities designed to restore normal daily life. During this phase they deal with the temporary repair of facilities to ease public life and the psychological recovery of the inhabitants. The final phase of reconstruction aims in reallocating efficiency available resources to achieve the desired reformation of the economy as dictated by the new status that the disaster has created.

Like individuals and firms, government policies regarding the confrontation of natural hazards and the recovery from a disaster depend on a variety of factors. Disasters are also called “focusing events” or “turning points” and play an important part in setting the government agendas. The severity of the impact on the society and the extent that their losses are publicly recognized (rather than the size of the hazard) determines the effort that the authorities will spend for restoring (Birkland, 1997). Another point made in the literature regarding the political will to protect from natural disasters, is that many measures for managing natural hazards are not popular. For example, if the government decides to print maps indicating areas with high flood hazard, this would affect the real estate market and probably compromise the value of land (Yeo, 2003). Similarly, there is evidence that inappropriate planning and legislation can exacerbate vulnerability (Pelling, 2003).

At this point it should be emphasized that the choices made by private investors and government are interdependent and therefore when governments design policies, they must account for how private investment and individual protective behavior will respond to the policy structure and relief effort. Smith et al. (2006) give the example of how California increased the safety of levees to protect the development that took place in the Sacramento-San Joaquin Valley. Furthermore, studies suggest that is more optimal for governments to focus on public policies that are adopted prior the occurrence of the natural disaster (Kydland and Prescott, 1977). Policy should provide incentives for choices and selections to be implemented at early points of time to help avoid or reduce the undesirable impacts. Such mechanisms as grants, loans and taxes can be used to help reduce risk (Institution of Civil Engineers, 1995).

Filatova et al. (2011) comment on the experience of Netherlands in order to show that that due to the lack of instruments to share the responsibility for flood risk reduction between government and individuals the Dutch government creates all the motives for urban developments to be skewed toward costal development promoting economic inefficiency. The authors argue that insurance is an example of a shared responsibility arrangement for flood protection between governments and individuals. Such a notion could be applied in Netherlands where a collective responsibility (society as a whole is responsible but nobody in particular) doesn’t encourage risk awareness and it even increases coastal flood risk. The authors note that in the case of Netherland that defence measures are financed via the tax system which does not differentiate between risk levels in the location of taxpayers and actual tax payment, the introduction of an insurance against flooding that implies a partially individual responsibility for flood risk, seems to make the Dutch very reluctant to it. This example shows also the important difference between collective and shared responsibility. Nevertheless it is regarded that both insurance and technical solutions such as building on higher elevation have direct measurable effects on individual location choices and, consequently, on flood risk reduction and they also create a ground for shared responsibility between government and individuals for flood risk reduction.

Treby et al. (2006) put the emphasis on a need for more understanding of the reality of flood risk, not only by the public, but all responsible parties. Another also important point is that it should be admitted that Government (central and local) and associated agencies, house transfer professionals, insurance industry, housing industry and the public all have an element of personal responsibility. However, in any case it is recognised that it is the government, not commercial bodies such as insurers who have the role of ensuring social rights and constructing expectations and hence they have a role in alleviating pressure from the insurers.

Overall, it is recognized that under conditions of both socio-economic and environmental change a portfolio of both structural and non-structural measures robust to uncertainties is need (Dawson et al., 2011). Dawson et al. (2011) adopted an integrated approach to flood risk analysis to explore the effectiveness of non-structural measures such as land use spatial planning, insurance and flood resilient construction. The case study was Thames Estuary in the UK and a number of scenarios that might lead to substantial changes in existing planning and insurance policies in the UK were assessed. Results showed that in all scenarios substantial flood risk reductions are possible, while the effectiveness of non-structural measures is however sensitive to socio-economic changes and governance arrangements. On the other hand, structural measures achieve the greatest reduction in more individualistic and less risk tolerant scenarios.

The authors also conclude that: “Whilst the benefits of non-structural measures have, to date, been difficult to appraise it is clear that they can offer greater benefits in terms of reducing vulnerability if implemented within the right governance context.”

PLANNING FOR NATURAL DISASTERS IN A STOCHASTIC WORLD

This section deals with various policy pitfalls that arise with respect to natural disasters as well as possible strategies for coping with the enormous losses that follow a catastrophic event.

A useful insight on planning for natural disasters is provided by the Final Report for the NOAA Coastal Service Center (Morrow, 2009) that offers experts (from academia and private sector) contribution on risk behaviour and risk communication. The aim is to lighten the interrelationships that may exist between the procedures that generate risk beliefs and behaviours on one hand with the strategies and measures that may be effective in promoting better understanding of coastal hazards and more effective responses. What is important is to achieve coastal hazard resilience. This is possible if local decision-makers help the general public understand the linkages between hazard impacts, community vulnerabilities, and policy alternatives. In order to do that it is necessary for them to have better knowledge of the processes involved in risk perception, how these perceptions are influenced by experience and how people decide how to act especially while under stress. An understanding of how risk is perceived makes possible for decision makers to identify what it takes for people to be concerned enough to take mitigating action. In this framework, strategies should be adapted so that they promote citizen understanding of coastal hazards and provide more effective mitigation and response.

Hence, primary it is recognised that risk reflects personal experiences and circumstances, and is highly influenced by context, such as social networks. Defining risk as hazard + outrage (Sandman 1987: cited in Morrow, 2009), it is noted that there is an inconsistency in policy design and risk management strategies in that there is a tendency for the public to pay too much attention to the risk dimension associated with the level of dread or fear (that is the outrage), and for experts to pay too little attention to it. Hence, the outrage effect is the main reason for the gap between risk assessment constructed by experts and the risk perceptions of the general public.

Within the report, special emphasis is also put on the issues of risk attitude, risk assessment, risk communication and contribution of social marketing. With regard to the first, experts are advised to focus where there is greatest chance of success in improving risk behaviour as there is a variance in individual's risk attitude (some people are more conservative other may even seek risk). Risk assessment is an important component of coastal management especially when citizens are engaged in the risk assessment. That makes it more likely to accept the results and to perceive their risk adequately. The source of risk announcements can also make a difference as flood risk announcements made by authorities or others from outside the community without understanding local context are frequently contested or rejected. Considering risk communication it should not be underestimated that it is important for risk managers not to over-warn, or even to over-communicate, as there is a limit to how much we can worry about. Another important element of risk communication is acknowledging uncertainties and unknowns so as to build credibility as well as interacting with the stakeholders. In particular, trust and credibility can be especially important, and difficult, in poor and minority communities. Overall, strategies should be based on the understanding of relevant community and should target separate messages to specific stakeholders according to their values, interests, and needs. Communication tasks that improve risk assessment have been divided into four general types: (i) information and education, (ii) behaviour change and protective action, (iii) disaster warnings and emergency information and (iv) joint problem solving and conflict resolution (Covello, von Winterfeld, and Slovic 1986: citied in Morrow, 2009).

In the context of the report considerable attention is also given to the contribution of community-based social marketing in changing risk-related behaviour and hence promoting coastal risk management goals. Therefore, it is highlighted the fact that risks are shared and experienced collectively and that people look to their social networks for information and guidance. For that reason it is very important to facilitate community interaction to change risk behaviour.

The report summarises output from interviews with risk analysis and communication experts and with persons involved in social marketing campaigns as well as findings from the literature, in order to provide guidelines to develop risk management strategies. In particular, it is emphasised that risk managers should:

- Know their audiences – their circumstances, values, resources, and available options;
- Target their messages to specific stakeholders;
- Focus on a specific behaviour;
- Use a positive approach;
- Begin with the easiest audience and use them to change social norms;
- Present the least amount of information necessary to make the point;
- Promote their assets such as the skills they already possess in dealing with uncertainty;
- Build trust – trusted messengers are more likely to be believed.

As a result, overall the two main points highlighted as best practice in order to achieve the above points are summarised as (i) knowing your audience and (ii) looking for structural factors.

A particular interesting approach to climate change adaptation under uncertainty is offered by Wardekker et al. (2009) who suggest that local actors could apply principles of resilience in order to make the system less prone to disturbances and to enable quick and flexible responses. The authors argue that the resilience approach is better capable of dealing with surprises than traditional predictive approaches as it is a more flexible approach to adaptation that can be more suitable and tailored to local situations than rigid top–down regulations.

Particularly, in their paper the authors foresee that climate change will increase flood frequencies and other disturbances in urban coastal delta while participants identified, through wildcards, disturbances as issues of societal disruption, property damage, and attractiveness and image of the area. Examples of adjustments that local actors can apply to improve climate adaptation according to the principles of resilience include: greater clarity on responsibilities, early-warning, response, and feedback mechanisms, spatial planning strategies that reduce impacts or enhance recovery, and flexible structures, infrastructure and flood defences, diversification of transportation options, and creation of multi-functional spaces and buildings, planning of horizons, possibly combined with cradle-to-cradle approaches, and planning easy-to-modify land-uses in areas that may need quick modification, enable local populations to self-respond to disturbances and increase public participation in climate adaptation, create disturbance-proofed, low-elevation spaces (e.g. squares and parks) and ground-floors, create multiple routes for electricity supply and transportation and multiple access levels for buildings. Finally, the authors argue that “resilience provides a useful approach that is robust to the many uncertainties that decision-makers face regarding climate change adaptation, including to surprises, and therefore has added value for climate change adaptation” (p. 11).

Following resilience principles as identified in Wardekker et al. (2009), an attempt is made in the context of this Report to explore whether insurance schemes can promote coastal hazard resilience (see part III). For example, it is regarded that resilience can be achieved through: the monitoring capacity of insurance schemes, their ability to use local participation, cooperate with local authorities , allocate part of the insurance fees in order to finance protection measures in the most affected areas, promote cohesion of social network and emphasise on the priority of safety measures, allocate payouts giving priority to the most affected or according to social criteria (e.g. income), collaborate with other insurance companies to hedge against a huge shock, link premium to risk reduction measures that promote buffering (e.g. flooding-resistant functions on ground level), capacity to offer “risk pool” policies for communities, firms etc.

According to Crichton (2007), the insurance industry will have an increasingly important role in helping society to adapt and become more resilient. Some ways in which insurers can help are (Crichton, 2008):

1. Assistance with identifying areas at risk.
2. Catastrophe modelling.
3. Economic incentives to discourage construction in the flood plain.
4. Collection of data on the costs of flood damage to feed into benefit cost appraisals for flood management schemes.
5. Promotion of resilient reinstatement techniques.
6. Promotion of temporary defence solutions.

Furthermore, the author noted that the success of insurance schemes depend on how flood insurance cover is arranged within a country, how sophisticated the country’s insurers are in mapping flood risks and how much the insurers are regulated by government (Crichton, 2008).

At this point it is worth referring again to the case of USA and UK as two examples of different insurance markets whose development and effectiveness is conditional on governmental regulation. Hence, in the case of States federal flood insurance is only available where local governments have adopted adequate flood plain management regulations for their floodplain areas as set out by the National Flood Insurance Program (NFIP). Criticisms of this system of organization include that setting (compulsory) mitigation standards contributed to reduce flood losses on new structures but on the other hand, the NFIP program failed to restrain development in flood plains, which may be the case because many premiums are not risk based but partly subsidized, reducing the cost of insurance premiums (Burby, 2001).

On the other hand, in UK flood recovery and resilience relies on a commercial market-based insurance system for its management and mitigation is generally advisory. However, UK floods in late 2000 brought changes with an impact on its organisation and effectiveness. Hence, in the new context insurance industry requires action from Government in the form of commitment to providing adequate flood defences or improvement to existing structures, improvements to flood warning systems, etc. as it has no desire to withdraw flood cover from property insurance policies. Hence, what is observed is a strong reliance on structural measures to reduce the risk of hazard rather through vulnerability reduction, while the presence and availability of flood insurance is preventing people from addressing underlying flood risk to the full extent (Treby et al., 2006).

It is reminded that within THESEUS project framework, the output of qualitative questionnaire surveys (presented below) in the case study areas is going to explore how different agents (households, businesses, local authorities and insurance firms) evaluate resilience issues. Furthermore, another important contribution is that of Santander's CE survey. In particular, the employed questionnaire and research design offers the possibility to elicit public's preferences regarding different climate change mitigation alternatives and also understand households' perceived risk. Hence, an important part of the survey is the CE valuation task that aims to elicit public's value related to the protection of wildlife, human health and recreation that mitigation measures have an impact on. Furthermore, by adopting a split-sample approach the sensitivity of the derived welfare measures will be investigated under different time horizons (5, 30 and 60 years). Other elements of the survey are to explore the discount rates of households as well as their risk preferences. Overall, it is regarded that understanding people's flood risk perceptions and preferences will provide useful insights to policy making towards the design of efficient and effective climate change mitigation programmes.

Building Flooding Research Group (2008) report on the impact of flooding on the value of residential property in the UK provided also recommendations which could be proved very useful for areas that experience similar disturbances. In particular:

- Information on flood risk needs to be better defined so that the specific risk to an individual property may be more accurately determined. This will benefit owners and occupiers by providing more certainty for the purposes of planning mitigation measures and in obtaining commercially-realistic building insurance cover.
- Both new developments and refurbishments and repairs to existing properties in flood risk areas should be carried out with a view to defending against and mitigating the impact of flood events.
- Property transaction professionals have an important role to play in the sale process of such properties to ensure that prospective owners are aware of the risk of flooding.

- In the light of the probable increase in storm and flood events in the future, the Government should continue with and expand its current policy of strengthening flood defences and increasing the effectiveness of flood warning mechanisms.
- Insurers, mortgagors, surveyors, and government agencies should continue to work together to ensure that flood risk cover is maintained as an integral part of the buildings insurance product wherever commercially possible, to safeguard the value of properties in flood risk areas.
- Further studies should be undertaken to determine how flood risk information may be sourced, co-ordinated and applied, to enable fair and efficient flood risk management, insurance, and defence strategies to individual properties to be formulated and applied.

In addition, several recommendations are offered from the literature:

A very important point made in Morrow's Report (2009) is that risk assessments constructed by experts tend to differ from the risk perceptions of the general public. Hence, experts are likely to consider their own perspective as being purely objective and to underestimate the fact that citizens' risk perceptions are affected by the norms of the groups with which they identify involving unique experiences, values, emotions and power. Furthermore, experts tend to negate the average citizen's ability to understand their perspective.

Treby et al. (2006) focusing on the UK experience notes that "Although social and technical issues are already being integrated to understand and manage flood, practitioners are now realising the importance of accommodating public hazard understanding and perception of risk into their management models, and there remains a need to fit such ideas to the insurance-based system of flood management in the UK" (p.351).

As far as the public intervention is concerned, whose contribution is regarded necessary, it is very important for decision-makers to understand the impact that their policies have on public's risk behaviour. Experience has proved that there have been cases that measures on the agricultural field taken to protect the environment had opposite effects as the impact on their risk behaviour was not accounted for (Koundouri et al. 2009; Groom et al., 2006). Hence, once more "outrage" dimension of risk is of particular significance when designing strategies. Koundouri and Nauges (2005) argue that a policy instrument can affect farmers' revenue in terms of both production and insurance behaviour and such an interaction should not be underestimated by policy-makers. The importance for policy-makers to understand farmers' risk preferences was highlighted in Groom et al. (2006).

Viscusi (2006) also emphasised that there is an interrelationship between individual behaviour and structure of government policies and as a result, policy makers should recognize that the policy choices they make with respect to post-catastrophe aid will affect the future levels of exposure to risk.

The interdependence of private investment responses to the level of government protection was also stressed out in Kousky et al. (2006). As the authors note this interdependent game may lead to less than ideal outcomes. Kousky et al. (2006) explore questions such as whether the government should permit New Orleans to be rebuilt based on centralized individual decision-making. If individuals are given complete freedom to invest in the high-risk areas, then that flexibility will generate an impetus for increased government protection of these areas once the investment has taken place. As a result, there may be multiple equilibria, and there is no assurance that societal choices will result in an efficient equilibrium outcome.

Kunreuther and Pauly (2006) argued that people do not generally self-insure due to a variety of behavioral irrationalities, such as underestimating the likelihood of a catastrophic event or its effect on their well-being. In the light of this irrationality the authors suggest various remedies among which the necessity to formulate a policy with respect to disasters before disasters have occurred to ensure efficient behavior on the part of those exposed to the risk, and on the decisions of those who are not yet exposed, but who could be depending on their locational choice. Furthermore, they recommend mandatory disaster insurance so that individuals will be required to have insurance coverage. Kunreuther and Pauly (2006) recommended that people should internalize the financial risks of disasters ex ante as it may be more efficient to have an ex ante public program to ensure coverage of catastrophic losses and to subsidize low income residents who cannot afford coverage rather than the current largely ex post public disaster relief program.

This point highlights as well the need for policy-makers to consider different moments in the risk cycle. Hence, a natural disasters management strategy should be based on carefully assessing and planning before, during and after the disaster occurs.

It should not be also overlooked the fact that there is a distribution of sensitivity and resilience to hazards across geographic space, and between social sectors.

Strict zoning coupled with mandatory insurance for those exposed to natural hazards was also suggested by Lave and Apt (2006) as well as a benefit-cost framework to the design of disaster policies accounting for the interdependence of government protection and private investment responses. Another contribution of Lave and Apt to policy recommendations is the potential role of information. The authors argued that people do not have well-formulated, accurate risk beliefs concerning the low-probability, high-loss events associated with disasters and therefore the government could provide more information to people and foster more rational risk taking decisions. Furthermore, in their view the government should focus more on information provision regarding small and moderate natural disasters as there is little that can be done to address large disasters.

Another interesting lesson is offered by the failure of traditional crop insurance where in developed countries traditional multi-peril crop insurance is widely used and heavily subsidized. However, this approach has been characterised as failure and as main causes are considered the very high monitoring and administrative costs, adverse selection and moral hazard. In fact, the “asymmetric information” insurer and insured have about the causes of a loss, are likely to determine “adverse selection”, as farmers presenting a worse than average risk are often the only one to buy the insurance, and “moral hazard", since once insured farmers lose incentive in minimizing their loss (Morduch, 2001; Mapfumo, 2006).

Kunreuther (2001) stressed the importance of private insurance as a catalyst for reducing losses in the future and covering much of the losses from catastrophic risks such as natural disasters. The author suggested a combination of building codes, reinsurance and indexed cat bonds that can form a useful strategy for reducing losses to property owners as well as insurers and the investment community. Kunreuther argued that the success of a disaster management program requires the active involvement of a number of interested parties from the private sector such as insurers, banks and financial institutions, realtors, builders and contractors.

Kunreuther (2001) focusing on the public sector argued that agencies have a role in providing assistance to low-income families so that they can adopt cost-effective mitigation measures, and so that they can recover after a disaster. Furthermore, the government may want to provide catastrophic reinsurance to insurers if the private sector does not offer sufficient coverage. Another proposed option is for the government to provide reinsurance protection against catastrophic losses. Private insurers would build up the fund by being assessed premium charges in the same manner that a private reinsurance company would levy a fee for excess-loss coverage or other protection, without charging insurers the higher-risk premium that either reinsurers or capital market instruments would require. Finally, it is noted that public sector damage from catastrophic events such as natural disasters often results in a substantial cost to taxpayers. Government officials should be encouraged to purchase insurance for public structures and invest in cost-effective mitigation measures. With respect to natural disasters one way to do this is to change legislation so that recovery funds would not be available unless municipalities implemented cost-effective mitigation measures. Another way would be to levy property taxes on all community residents to cover losses to public structures from catastrophic losses forming a community-based insurance, with all residents paying a share in proportion to the value of their property.

Filatova et al. (2011) present the Dutch water management case in which traditionally the focus has been on reducing the probability of flooding by means of engineering defense constructions (i.e. strengthening dikes and dunes). In that way individuals investing in coastal zone do not bear any risk personally as the government has the collective responsibility to keep total flood risk from growing. As the authors argue, "the decrease in total flood risk due to lowered probability of flood defense failure is vanished if the economic value of the area continues to grow in zones vulnerable to flood. Flood risk can be really reduced only if engineered coastal defense measures are complemented with an economic use of a flood zone that ensures less potential damage." (p. 164). Hence, authors note that effort should be put to decrease both multipliers of flood risk (probability of event and effect) and policy-makers may create incentives giving individuals a possibility to make location choices that lead to less total flood risk in the coastal zone area.

Authors argue that in order to decrease risk of flooding in coastal zones, an important option is to increase individual coastal flood risk awareness, as even if there is knowledge about the probability of disaster that does not imply awareness about consequences. In this context, risk awareness can be positively influenced by personal experience, risk communication, financial mechanisms and technical engineering solutions. Regarding personal experience impact, broadcasting and visualizing previous experiences may be an important component of a risk communication strategy. In terms of risk communication it stressed out that it is important for decision-makers in water management that operate with a technical notion of risk to realize that it is quite different from the notion of the general public about risk. Therefore, it is important to present information in a way that is acceptable by the public. Financial mechanism that can promote risk awareness is insurance against flooding. Hence, apart from a risk-sharing strategy insurance may serve as a measure to communicate this risk and to persuade people to integrate it in their decision making by making it compulsory in flood prone zones. In particular, housing markets in the countries where flood insurance is present (mandatory) reveal a decrease of prices due to insurance pressure on individual budgets. In that way, flood insurance conveys risk information to participants in the coastal housing market. Finally, engineering solutions that can decrease risk of flooding without creating a false feeling of safety could be the construction of new developments on higher grounds. That not only decreases direct damage in the case of flooding, it also serves as a persistent flood communication signal that reminds that flooding may happen, thus reviving individual risk awareness.

Clarence Wong, Swiss Re's Chief Economist Asia, discusses how public-private partnerships can proactively help manage the mounting cost of disaster relief . According to the expert, public-private partnerships, especially those involving reinsurance and capital market solutions, can improve disaster planning and prepare stakeholders for the consequences of climate change. They can also facilitate risk awareness and joint solutions using various risk transfer mechanisms. Mr Wong suggests solutions for risk prevention, risk transfer and financing:

- Partnerships for risk prevention: Insurers have the expertise needed to identify risk prevention measures and can offer more attractive premiums if such measures are implemented. The public sector, on the other hand, is better able to enforce and finance risk prevention measures, such as building codes, fire prevention regulations, etc.
- Partnerships for risk transfer and financing: Government can play a significant role by creating a legal framework that enables market mechanisms to function. Given the insurability challenges, the public sector can assume different roles in each transaction. For instance, the public sector may be involved in:
- The development of risk transfer solutions that involve the collection of critical exposure data. In doing so, governments can also draw on the support and know-how of re/insurers.
- Expanding the availability of risk transfer solutions for individuals and corporations.

- Becoming the de facto insurer of last resort; it can support protection coverage on a national basis and can partner with the private sector to transfer the risk using international reinsurance or capital market solutions.

According to the expert, the public sector can transfer the expenses stemming from immediate relief and emergency efforts, while the main benefit is improved budgeting certainty and lower debt levels after a disaster. The following figure provides an overview of different loss financing mechanisms and instruments from government's perspective.

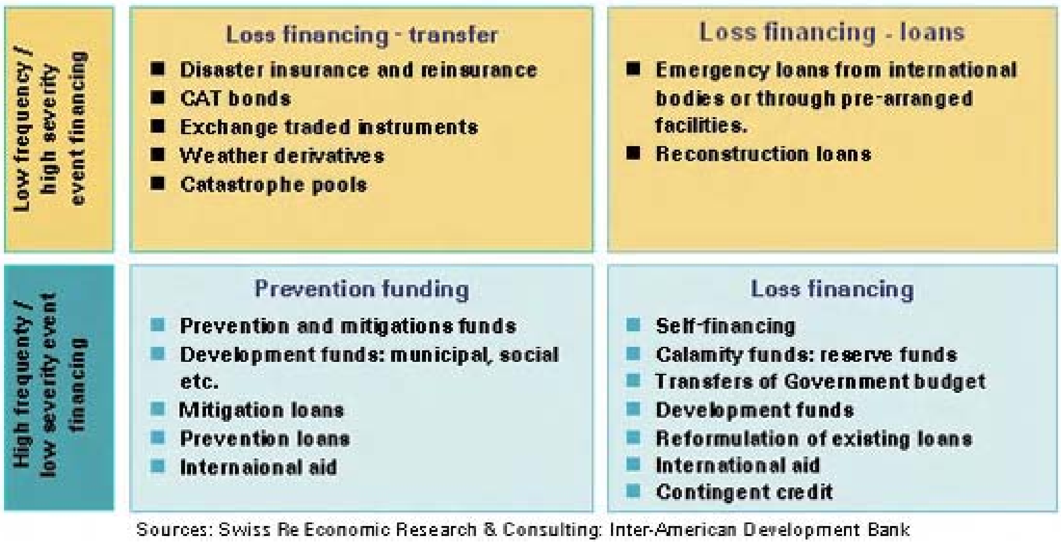

Figure 8: Loss financing mechanisms and instruments.

Flood insurance needs to be viewed as a flood management tool that provides three main functions (Arnell 2000):

- Reimburse damage costs to promote socio-economic resilience.
- Enable spread of irregular and geographically confined flood losses over time and space.
- Encourage actions to reduce exposure and vulnerability to flood loss.

Flood insurance can aid floodplain management by influencing decisions to locate in the floodplain and it also has the potential to encourage the use of measures to minimise damage (Doornkamp, 1995; Arnell, 2000).

Overall, insurance schemes can decrease vulnerability and impact positively on coastal resilience as they provide households and businesses with the potential of an ex ante mitigation mechanism. In this framework, government's intervention is of crucial importance as policies interact with the formation of risk behaviour and are capable of creating incentives to both households and investors. Hence, apart from exploring more community's risk perception conditional on the factors previously mentioned it is also important to acknowledge the above interlinkage in coastal policy design.

INTEGRATION OF INSURANCE SCHEMES INTO THESEUS

At this point it should be noted the contribution of THESEUS on flood and erosion analysis. In particular, THESEUS suggests a risk assessment based on a system's understanding of flooding. Underlying this approach is the Source-Pathway-Receptor-Consequences (S-P-R-C) model which defines the links between system components thus potentially giving a better understanding of the flooding system as a whole. Specifically, the S-P-R-C approach is being used to evaluate how the Sources (waves, tide, storm surge, mean sea level, river discharge, run-off) through the Pathways (coastal defence units) affect the Receptor (inland system) generating Consequences (economical, social, environmental, affected population, land losses). The purpose of S-P-R-C is to provide (i) a clear definition of the flood system and (ii) a conceptual map showing the inherent, causal relationships and interdependencies that will need to be represented in the analytical flood assessment framework. Use of this methodology encourages clarification of underlying or implicit assumptions and local knowledge which will provide significant benefit later in the project, particularly the assessment of whether the greatest benefit for management techniques should be focused on reducing the probability of the event at either the source or pathway stage, or altering the magnitude of exposure to the event by managing the receptors. Hence, unlike many earlier flood assessments, THESEUS is considering the consequences of flooding on both the human and natural systems.

The S-P-R-C model (presented also in Figure 9) initially defines the baseline or current situation, while the steps required for the S-P-R-C model are:

1. Define case study boundaries and flood system components
2. Define which sources and mechanisms of flooding are important for the site (Sources)
3. Define the existing management practices
4. Define the areas of interest (potential Receptors)
5. Define the impacts of interest (potential Consequences)
6. Define the routes for flood water between 2, 4 and 6 (Pathways)

Trying to integrate insurance schemes in this context, in order to assess their effectiveness, we can see that they interact with the model in different ways as presented in the following Table 1 and Figure 9. The most obvious link is the impact of insurance market on consequences. In particular, by increasing risk awareness (linking premium to risk) and creating incentives for mitigation actions there is a direct impact on the consequences and in particular on the expected damages and number of people flooded through the reduction of the vulnerability and exposure in flood prone areas. Insurance arrangements for flood risk may require households to undertake measures that mitigate damage or stimulate households to undertake precautionary measures voluntarily (Kunreuther and Pauly, 2006). These mitigation measures may limit damage during floods and thus be complementary to traditional flood protection (Botzen et al., 2009).

Furthermore, insurance schemes impact also on receptors. By linking coverage to mitigation actions (e.g. keeping valuable items above flood level) or by even not entering an area to provide coverage they impact on the nature of receptors namely, buildings and infrastructure that become more flood proofing but also on people and agriculture/mariculture activity who will have now either to adapt to insurance's prerequisite for mitigation (if available) or to bear totally the risk of flooding in case that coverage is not offered. In the last scenario, it is more likely that less risk-averse households and firms will chose establishing in flood prone areas.

One could also argue that insurance seen as a management tool could be part of the pathway section along with engineered management since it can alter the character of the floodplain not in terms of depth, duration etc but in terms of development taking place in that area.

Finally, another contribution of insurance could be its contribution in R&D since a considerable investment takes place in understanding more source, pathway features as well as their interaction.

Table 1: S-P-R-C and insurance

Source	Pathway	Receptor	Consequences
Not applicable: insurance schemes do not affect the source of flooding,	Some effect through pathway adaptation.	Major effect of insurance schemes on the exposure of assets at risk and their vulnerability as well as on the nature of receptors.	By increasing risk awareness (linking premium to risk) and creating incentives for mitigation actions there is a direct impact on the consequences and in particular on the expected damages and number of people flooded through the reduction of the vulnerability and exposure in flood prone areas.

Kunreuther (2001) states that mitigation measures reduce the impacts of a disaster. Although risk mitigation is achieved primary by using technologies or procedures to reduce vulnerability by limiting the effects of any occurrence of a hazard e.g. flood warning and flood proofing, flood insurance is related to risk transfer that is managing exposure by passing the cost imposed by the exposure to a financial device such as compensation, emergency aid or (most important) insurance. Treby et al., (2006) criticising the reality of insurance market in UK, notes that if a clear link is established between flood risk and property value, this information might be used to raise awareness and as an incentive for home owners and property transfer professions to take actions to mitigate their flood risk.

As Clark (1998) notes "Clearly it lies at the core of risk transfer strategies, but it also plays a major role in risk avoidance, prevention, control and mitigation by imposing (as a policy condition) or encouraging (by lobby and by the incentive of variable premiums, exclusions or deductibles) measures which are deemed to reduce the occurrence, severity or impact of a natural peril." (p. 335).

As a result insurance schemes reduce the consequences through policy condition or through encouraging measures, which are deemed to reduce the occurrence, severity or impact of a natural peril but also modify the nature of receptors by influencing the structure and development of economic activity on coastal areas prone to flooding.

A useful insight on the assessment of flood risk is offered by Daswon et al. (2011). The authors in their risk analysis framework (Figure 9 below) used in their study included several components. At the top of the figure are the socio-economic drivers of change that influence population growth at a regional scale. Market and planning instruments such as insurance, impact on flood plain geography and development preferences and hence on land use. The integrated assessment presented below demonstrates the influence of different socio-economic scenarios, climate scenarios and flood risk management policies on risk assessment scenarios.

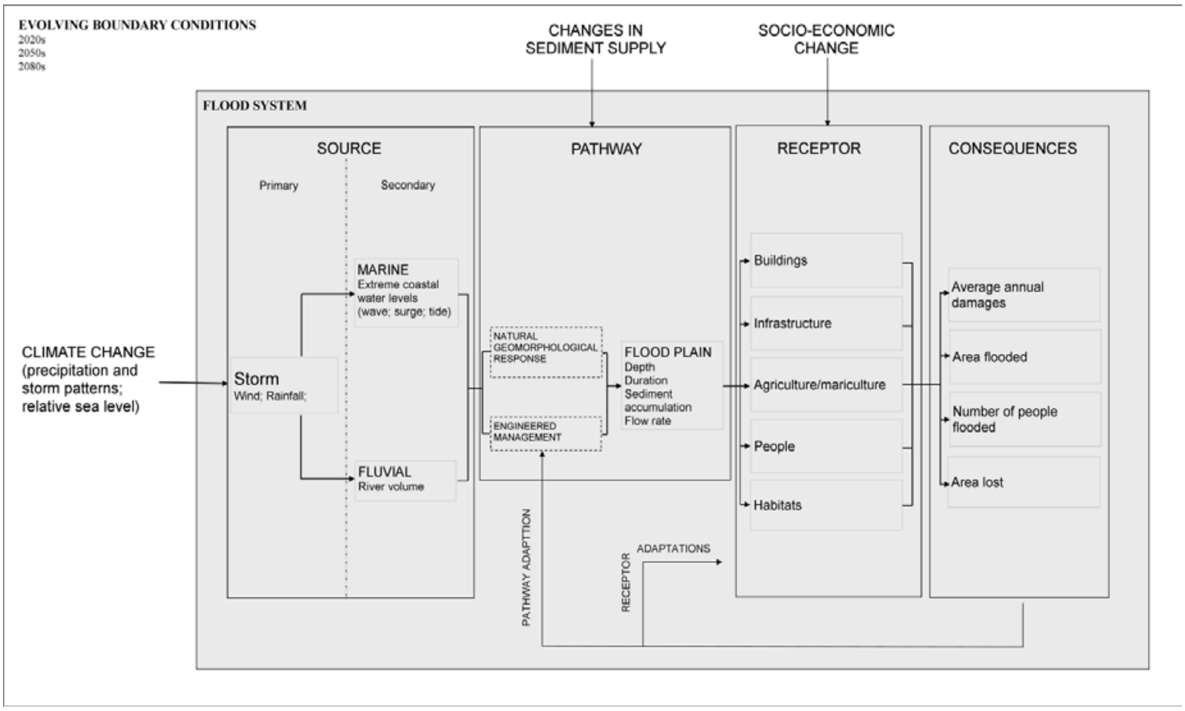

Figure 9: Overview of risk analysis framework, highlighting how the drivers of change and non-structural flood risk management measures interact with the risk calculation (Dawson et al., 2011).

From this information, it is possible to identify the important factors which affect flood events. The future change in these factors will be described and, where possible, quantified using evidence from the literature and from results obtained by surveys, modelling in study sites and expert knowledge. Scenarios will enable descriptions, for instance, of how changes in climate conditions may produce changes in flood pathways (overtopping of banks, breaching of dunes/dikes) and consequently in portion of flooded areas that may affect different receptors in different ways. The objective is to generate, for each study site, coastal flooding hazard maps for the present situation (2010) and for three scenarios: short (2020's), mid (2050's) and long-term (2080's) scenario, as well as to determine short, mid and long-term erosion scenarios.

The advantages of THESEUS risk assessment are that it adopts an integrating approach that considers how the sources generate consequences of various dimensions (economical, social, environmental, affected population, land losses). Furthermore, it incorporates input from experts, local knowledge and literature. The produced coastal flooding hazard maps will be a useful and direct tool that will enable flood and erosion analysis for current and future scenarios. Most importantly, the adopted approach acknowledges the fact that 'risk' is a human or societal construct and an inherent characteristic of the natural system. Finally, recognising the fact that flooding or erosion may be essential to the continued existence of particular species or habitats, some terminology has changed compared to earlier projects. A characteristic one is the concept of 'Hazard' been replaced by the less judgemental 'Flood event'.

GROUND TESTING INSURANCE: INITIAL STEPS

In order to explore how society perceives risk of coastal hazards and insurance schemes, questionnaire surveys were run in different EU case study areas (Spain, UK, France, Poland and Bulgaria).

It should be also reminded that the output of Santander survey will give the opportunity to shed more light on how people that live on an impacted coast view climate change effects. In particular, one of the aims of the employed questionnaire is to understand people's risk perceptions and in particular flooding risk. Examples of included questions are:

-What are the three environmental risks that you find most worrying for Santander?

-How severely do you believe the following goods and services (recreation, wildlife, tourism, and health) are nowadays threatened because of climate change and sea level rise in Santander?

-In your current house, do you feel threatened by flooding risk?

-Are you privately insured against damages due to floods?

-In order to avoid or manage flooding risks who do you trust the most?

Other studies that have asked consultation of experts in order to identify how issues of flooding and shoreline erosion are perceived by the public are those of Morrow (2009) and Building Flooding Research Group Report (2008).

In particular, an important part of the Morrow's Report (2009) cites experts' views in risk analysis in order to explore possible ways and best practices to improve risk communication and behaviour towards risk. As a result, very important points from these interviews were raised:

Experts agree on the importance of social marketing as a tool of targeting two separate components: people and context. The latter tends to be more important factor in changing behaviours. Risk managers should make effort to communicate and influence opinion leaders who are recognized persons within a community. This is a more effective way of changing social norm and thus correcting the risk assessment. Apart from the opinion leaders, effort needs to be made to identify and understand alternative audiences, acknowledge their current state –their circumstances including barriers, values, attitudes, experiences, resources and available options, because social marketing can be more effective when it is focused on the specific characteristics of a targeted group. Particularly, separate campaigns promoting the desired behaviour can be targeted to specific groups in the community. Interaction between experts and public is important for the success of social marketing.

Except from social marketing, experts tend to agree to more key points regarding risk communication. Several emphasized the importance of looking for structural factors that might affect the desired behaviour as structures are often more easily changed than people. Examples were derived from insurance market. Hence, insurance premiums should reflect risk while these who deserve special treatment and face high insurance premiums should receive some kind of subsidy. As a result, the degree of risk could be reflected in the real estate transactions. Priority to safety could be also highlighted by post markers (in the case of flooding) showing the possible water levels, or the results of past floods in the community could be emphasised.

Other experts' remarks were that it should not be neglected the fact that people tend to have difficulties interpreting correctly low probability events and therefore it is preferable some times to compare risks and use longer horizons when referring to them. Regarding the focus and the content of the risk communications, experts suggest design messages that do not focus direct on the risk, but instead, use a positive approach and begin the campaign by aiming to groups which are more possible to accept the message and then expand to a larger target group. The message must be connected with very practical information, using the least amount of details to avoid being tiresome and inconceivable; therefore it will be easily accepted and understood by the targeted audience. Also, it is noted that it is important that there is a relationship of trust between the public and the messengers because trusted messengers are more likely to be believed.

Another study of qualitative character that asked experts' view is that of Building Flooding Research Group (2008) Report which had as objective to investigate the effect of flooding and flood risk on the valuation of property and the cost of insurance by means of questionnaires and interviews. Particularly, the impact on valuation was investigated by studying the approach and attitude of valuers and negotiators active in the residential property market by means of questionnaires, while insurance issues were also examined through interviews.

The main findings from the survey of valuers are:

- Properties which have flooded within the last 5 years are discounted in value with a median value of 12% while may be some months longer on the market than other similar properties.
- Properties in local markets where flooding awareness is greater may experience a greater discount, less than but comparable with properties which have been flooded. Patterns of discounting due to flood risk may vary significantly from area to area according to local knowledge and perceptions.
- Collapsed and renegotiated sales due to flood risk do occur.
- There is no clear consensus on how long price recovery to a flooded property may take.
- Valuers consider that building insurance cover is a significant factor affecting the value of properties which have had a flood in the last 5 years, and is a factor in the value of properties at risk of flooding but which have not been flooded.
- The sources of information on flooding and flood risk are variable, and in many cases, geographically -based rather than building-based. Valuers rely predominantly on local knowledge and liaison with their colleagues and other professionals for information, though the Environment Agency sources are used.
- Valuers' opinions about a banding system of properties at risk from flooding are divided.
- The impact of the forthcoming Home Inspectors legislation on flooding risk is uncertain, with many valuers expressing some misgivings about how an early identification of flood risk, if given in the seller's survey, may affect value.

Findings from the insurance industry investigation revealed that:

- There is no highly scientific method currently in use for determining flood risk and current methods rely heavily on the experience of the individual insurer.
- Flooding is just one of the many perils that are provided under the household insurance products and typically a holistic approach is adopted when setting premiums taking into account the risk of the various. Several major insurers have taken steps towards identifying post codes in high risk areas and up rating premiums.
- The Environmental Agency (EA) has been and continues to work closely with the ABI (Association of British Insurers) to support the industry's commitment towards providing insurance to the vast majority of homes and businesses in high risk areas. However, the EA has no role in determining insurance cover. The EA publishes indicative floodplain maps which provide a general indication of flood risk, but this is based on postcode and is not available for individual properties.

- The EA have provided ABI members with new data rated to show different probabilities of flooding. This information enables insurers to carry out a high-level analysis of flood risk thereby giving greater insight into the risk of an individual property. There exists some circumspection on behalf of the insurers with regards the reliability and accuracy of this new data and it is likely that it will be used in parallel with the information and experience of individual insurance companies.
- The ABI have established three new categories of insurance provision, based on the annual statistical chance of flooding in a given area and local flood defence investment plans.
- The EA and ABI are backing a new scheme to develop British Standards for flood protection products which insurers will take into account when establishing risk and premiums.
- The question of insurance premiums was considered to be very much based on an insurer's desired position in the market rather than on the flood risk alone.

GROUND PROOFING FURTHER STEPS

AIMS

This survey guide is designed to collect data via interviews to help meet the aims of WT4.1. These aims are:

- Explore the social perception of the flood and erosion risk in the case study areas to enable the efficient spread of the risk through the program. In particular, to test whether insurance rates reflect the individuals' perceived flood and flood –related erosion risk.
- Identify efficient insurance programs and the necessary incentives for their adoption by property owners.
- Identify the barriers for their adoption.
- Explore whether insurance promotes mitigation and therefore resilience in coastal areas along the lines of Wardekker's et al. (2009) principles.

METHODS

Sampling is expected to take place in autumn 2011 spring 2012 in different study sites namely UK, Spain, France, Poland and Bulgaria. The approach is fairly in-depth, semi-structured interviews. However, the aims are exploratory rather than focused on obtaining definitive responses and data for statistical analyses. The scope is that respondents will be mainly households of areas facing pressure of coastal hazards as well as business owners. One questionnaire will be also addressed to local authorities while if possible a fourth questionnaire will seek to explore insurer's point of view.

STRUCTURE OF THE INTERVIEW

The interview is structured around the following themes:

Theme 1: Households and site details

Theme 2: Personal experiences and perception of risk

Theme 3: Characteristics of insurance on study site

Theme 4&5: Resilience related themes which also identify possible barriers of adoption

LAND USE PLANNING[3]

SPATIAL PLANNING IN EUROPE: A LITERATURE REVIEW FOR THE THESEUS PROJECT

OBJECTIVES

The objective of this review is to provide a review of spatial planning and urbanisation policies in EU countries and guidelines for further case study site applications. This review focuses in the first instance within the UK, and more specifically England. However, it extends where possible to include some review of policy and practice within the five WT 4.2 Case study sites (hereafter Theseus case study countries), to other EU countries involved in the Theseus project (hereafter other Theseus countries) and occasionally to other EU countries. The review also aims to take note of themes within the literature on contributions of spatial planning to resilience building in relation to flood and coastal erosion risk management (FCERM).

RESILIENCE AT THE COAST

It can be argued that the power of the resilience concept lies in its effectiveness as an envisioning tool. In this respect the partnership between resilience thinking and spatial planning is critical to navigating challenges of 21st century flood risk management in the context of environmental and social change. The resilience concept is most useful in this capacity for two primary reasons.

Firstly, resilience is a relative concept. It is relative in terms that the social and physical environment being managed for resilience is defined by choices of actors regarding what are considered to be desirable attributes of the system. Measures of resilience are therefore a function of a normative statement on the desirably of particularly conditions and as a result different and conflicting notions of resilience are largely inevitable. Arguably what is most important is mapping these conflicting notions of resilience, and thus the collision of interests, to create the most useful insights into managing complex systems and risks.

In the second place, the challenges of social and environmental change mean that our use of resilience ideas must extend beyond the limits of recovering from shock. The application of resilience has to a large extent focused on enhancing the capacity of actors to adapt through learning and adjusting internal processes. This definition allows for temporary changes in functioning and dynamics, as long as the system remains within the same stability domain. However, resilience is also about the opportunities that perturbations open up in terms of recombination of evolved structures and processes, renewal of the system and emergence of new trajectories of change. The resilience paradigm could have the capacity to produce significant shifts in our normative vision of the future: such transformations might actually be critical to the sustainability of threatened coasts.

[3] Section authors: Loraine McFadden, Edmund-Penning-Rowsell and Sylvia Tunstall, Flood Hazard Research Center, Middlesex University.

The process of using resilience to equip decision-makers and communities with alternative social and environmental futures could be facilitated by innovative spatial planning. Due to the medium and long-term character of spatial plans and the persistence of spatial structures, spatial planning cannot react spontaneously to sudden threats or impacts. However, spatial planning might be considered an important vehicle for enabling communities to navigate through uncertainties and for facilitating cross-scale interactions in moving towards new coastal futures. Transforming threatened coasts is an increasing global challenge and advances facilitated by spatial planning could be of significant international consequence.

The literature specifically focusing on resilience is profuse, opening a field in which a wide range of concepts reside. However, following the discussion above and inline with the systems approach and literature on adaptive or resilience socio-ecological systems (e.g. Folke et al., 2002; Walker et al.,2004; Berkes, 2007), a number of strategic interdependencies can be identified as benchmarks for enhancing and facilitating resilience building: 1) engagement across individuals, communities or organisations that have some claim to involvement in the decision-making processes, facilitating a social process in which stakeholders argue, debate and negotiate values, this includes sharing management power and responsibility, 2) combining different types of knowledge with cooperation across disciplinary boundaries and building links between science and traditional knowledge and 3) linking management across the range of spatial and temporal perturbations within the system. This latter point involves taking a long-term perspective, in which learning is central and where iterative cycles in a strategy process provide a vehicle for modifying the process.

These benchmarks link with many of the issues of debate and the principles guiding spatial planning (see section below)

In practical terms, it should be noted that erosion at the coast presents a special and different challenge to considering the role of spatial planning in resilience building as compared with flood risk. Floods impose economic, social and psychological costs on communities but they do not necessarily, and indeed rather rarely, involve complete loss or abandonment of property and businesses, the exception being where there is very frequent flooding of property. Coastal erosion by contrast can involve in the long term total loss of property. Resilience and the kinds of adaptation involved thus may have very different meanings for flooding and coastal erosion.

Innovative resilience enhancement, social innovation and spatial planning.

The following literature review contextualises spatial planning in terms of the formal hierarchical planning processes through which policies and plans are developed and applied in all EC countries (see below). The discussion moves from higher-scale planning processes through to exploring spatial planning at the local-level. This context is both conceptual and institutional and is therefore provides a useful structure for the deliverable. However, this spatial arrangement of the review does not easily lend itself to structuring the discussions of resilience building ideas and processes from within spatial planning: issues which we hope to explore with stakeholders in the various WP4.2 case study areas. This is because resilience and innovation are themes which cut across the formal hierarchical scales of spatial planning. We envisage the local scale to be the level at which innovation is most likely to occur and that the local level is likely to be the key scale for understanding resilience building processes. However, we have formalised the survey guide (see below) to explore the potential for innovation and resilience building across each of the hierarchical scales: not least because what happens at the local level is enabled or constrained by compliance with policies and plans at higher scales.

One of the key messages of Work Package 4 is that technical innovation for coastal flood and erosion risk management depends on social innovation. That is, any new approach, practice or intervention, any new product designed to better or resolve a social problem, is only successful under the condition that it is adopted by institutions, organisations, or communities. Therefore a key theme underpinning the analysis within this work task is the identification of barriers and enablers to the implementation of resilience building processes in spatial planning. The following literature review outlines the main formal processes within spatial planning which might exert constrains or opportunities for implementation and where possible identifies specific barriers to adopting innovative methods. This information in turn provides the guidelines for exploratory questions in the survey guide for exploring this issue at the study site level.

Social innovation for resilience building requires a number of other conditions to be met in order facilitate the adoption of risk-reducing strategies and options. This deliverable has sought to complete ground-work from literature, which will help explore some of these themes in the study sites. One theme relates to the importance of the social problem being perceived by the adopter of the proposed innovation. In response to this issue, the literature review has focused on interactions and inter-relations between spatial planning and flood and coastal erosion risk management across the different management scales. Again this information in the review provides the structure for a series of exploratory questions which will be applied in the case study areas. These questions aim to identify if planning systems, and stakeholders relevant to spatial planning processes, recognise and know about the problems of coastal flooding and erosion. They also seek to explore if and how these stakeholders perceive spatial planning as an important and tool for addressing the problems of coastal flood and erosion risks.

A final theme within the review is the means whereby resilience building ideas might be mobilised within spatial planning for coastal risk management. The three resilience themes identified in the section above act as a broad guide to three basic benchmarks of a resilience and adaptive approach. We have used these benchmarks as a broad guide to the review of spatial planning in the incoming sections. That is, when reviewing each of the formal hierarchical processes of planning, we have asked ourselves:

- Is there information relevant to this scale on the role and importance of stakeholder engagement?

- Is there evidence of the existence and use of professional knowledge networks to allow integration of information on a range of system behaviours and functionalities of relevant to spatial planning decisions?
- Do current spatial planning processes facilitate iterative decision-making: is there evidence of creating capacity for increasing learning and building memory to learn from past events?

Where relevant, the literature review seeks to identify issues related to these themes, which in turn have defined exploratory questions which will be applied within each of the case study locations. This broad range of information exploring: knowledge of the problem, perceptions of the role of spatial planning, means of building resilience and barriers and enablers to mobilizing resilience ideas, will provide the broad framework in which 'options' for innovative spatial planning will be developed.

SPATIAL PLANNING DATA SOURCES AND LITERATURE

Literature searches indicate that there has been a surge of interest in spatial planning across the European Union (EU) from the 1990s. The European Spatial Development Perspective (1999) both reflects and has further stimulated this interest in spatial planning within the European Union.

The Directorate General for Regional Policy and Cohesion of the EC produced 'The European Compendium of Spatial Planning Systems' (EC 1997) comparing and contrasting spatial planning in the EU on the basis of 15 Member State reports on their spatial planning systems and policies. There are also country reports for the member states. It provides an authoritative and comparable reference work. However, it covers systems and policies as they were up to 1st January 1994. Thus, although the broad outlines of the planning systems described may be the same, much of this data may be out of date. As Healy (2004) notes in relation to strategic planning in European settings spatial planning ideas are dynamic and change in response to changes in institutional and political contexts.

A key data source is the European Spatial Planning Research and Information Data Base (ESPRID) a web-based Information source for researchers and policy-makers concerned with Strategic Spatial Planning in a European context supported by the EU and, England's Communities and Local Government (CLG), the department responsible for planning in England (http://www.esprid,org/). It contains varied and updated material from a wide range of sources, academic books and journals, policy reports, plans and policy statements, databases and websites. It also includes information on relevant experts. It has been designed to be particularly helpful to those involved in INTERREG programmes and ESPON 2006, and to those developing spatial strategies across Europe.

The ESPON Programme (European Spatial Planning Observation Network) seeks to support Europe-wide policy development in relation to the aim for territorial cohesion and harmonious development across Europe. It funds research projects and produces reports on issues for development within the EU as a whole (The ESPON 2013 Programme 2010). This reports on issues in Europe-wide spatial planning rather than about spatial planning systems and offers a form of Europe-wide spatial planning in the absence of a formal Europe-wide spatial planning system.

The Virtual Environmental Planning Project supported through the INTERREG IIIB North West Europe Programme, and other funders ran from 2003 until March 2008. It successfully developed and demonstrated interactive, 3D web applications to help lay people understand proposed planning developments and share their views about them online. It also provided brief summary information on spatial planning in four European countries, France, Germany, Netherlands, and England.

There is a an extensive academic literature focused on European spatial planning and a good representation of comparative academic studies on spatial planning in European countries and a large number of academic journals on spatial planning and some specialist journals including several devoted to European planning: e.g.' European Planning Studies'. However, many of the academic studies accessed focus on case study comparisons of particular plans in selected countries (Healy and Khakee 1997; Healy 2004; Adams et al. 2006; Albrechts et al. 2001), on particular aspects of planning such as Newman and Thornley's examination of urban planning in Europe (2002) and the comparative studies of city-regions by Salet, Thornley and Kreukels, (eds). (2003). There are also comparisons involving a limited number of countries, for example, only two countries, such as France and Britain across the whole planning systems (Booth et al. 2007) or aspects of planning systems. Other studies have focused on sectoral comparisons such as Marshall's work on infrastructure and spatial planning in four European case studies (Marshall 2009 a & b).

There are some academic studies that focus on spatial planning in relation to FCERM. Pottier et al. (2005) examined development and flood risk and spatial planning in France and Britain. In England studies by Tunstall et al. (2010) and Pardoe et al 2011 (submitted) show through detailed case studies how flood risk is addressed in the planning system. Some EU supported projects have examined spatial planning systems in various EU countries in a coastal context. For example, 'Vision and Strategies 2010 around the Baltic' reports on the spatial planning systems and policies of eleven Baltic coastal countries including Germany and Poland. The COREPOINT project has looked at the potential role of regions and spatial planning for improving the capacity for Integrated Coastal Zone Management (ICZM) in North West Europe in relation to COREPOINT sites in England, Wales, Scotland , Ireland, France and Belgium (Ballinger, 2008). In the UK there has been research interest in the extent to which spatial planning at national, regional or local level provides a means of addressing coastal management issues (Allmendinger et al 2002; Ballinger et al. 2006; Tyldesley 2005; Taussik 1996; 1997; 2007). Other studies have considered the potential links between ICZM and spatial planning for example Rabski (2004) on Poland whose coastal zone was significantly extended by boundary changes between 1939 and 1945.

This review has severe limitations partly due to time constraints in dealing with such complex source material. The review has also been constrained by the follow key issues relating to knowledge and information on spatial planning in Europe:

- The diversity and complexity of spatial planning systems across Europe and the difficulty in the terminology used and of knowing that like is being compared with like.

- Data has needed to be accessed for the most part in English. Therefore, much material of interest may not be used. It has proved impossible to access many key planning documents such as planning acts or guidance documents because they were not available in English.

- The difficulty in finding up to date information and the uncertainty as to the date of some material. Planning systems are dynamic and changeable. A limitation of the academic literature is that due to the slowness of the academic publishing process many journal articles and books are based on research conducted some years earlier and may not reflect the current situation. In England, changes in government tend to bring changes in planning doctrine and fundamental reassessment and rearrangement of the planning system. This can be seen in change from the market led approach of the 1980s to the plan-led approach of the 1990s and changes introduced following the election of a Labour Government in 1997. This is evident in the changes that the 2010 Coalition government intend to introduce to the planning system.

  This review has had to make use of grey literature, often undated, available on the internet; much of it generated by EC projects and initiatives because other sources were not available or could not be accessed in time. It would have been preferable to have accessed more authoritative sources had these been readily available.

- The potential gap between strategies, plans and policies and their implementation on the ground. For example, Richards et al. 2008 have argued that there may be a gap between England's national policy on development and flood risk (Planning Policy Guidance 25 (PPG 25) on development and Flood Risk at the time) and its implementation. It is more difficult to find out about how policies and plans are actually interpreted and carried out. Data gathering whtin thee case studies may help to reveal this. Another possible source of information on implementation could be evaluations of spatial planning performance where they exist. For example, In England and Wales, the Environment Agency in collaboration with local planning authorities has been required since 2000 to report annually to central government on spatial planning and development management and flood risk issues (see for example, the most recent report, Environment Agency 2011).

There is a growing literature on spatial planning theory and an international academic journal devoted to this topic, 'Planning Theory'. However it is beyond the scope of the review for Theseus to engage extensively with this literature and the review will be focus on spatial planning structures, legislation, policies, plans, and practice. Even with this restriction, the literature on European spatial planning and on planning within specific EU countries is extensive and this literature review can only touch on some of the key similarities and differences in systems and highlight issues relating to spatial planning at the coast.

Meaning of spatial planning in EU countries

Spatial planning is a contested and ill defined concept. Certainly in the UK context, the meaning of the term remains ambiguous to key participants in the planning process (Royal Town Planning Institute 2007). 'Spatial planning' has different meanings in different EU countries even when the terms used to describe it are the same. The use and meaning of terms have developed over time and reflect history the particular legal, socio-economic, political and cultural forces at work in each country and indeed in some cases regions (European Commission 1997 (EC 1997)).

In France the idea of amenagement du territoire is linked to the administrative and political traditions of the country. It is concerned with the regional economic planning of territory at the broadest level. The same terms are used in Belgium and Luxemburg but have a different meaning. In the Netherlands the term ruimtelijke is closely associated with the traditions of managing a scarce land source and has connotations of major public sector activity in the development process (EC 1997).

Some countries have relatively stable spatial planning systems that have evolved over time. In England, the system has developed with some, mostly minor, changes over a period of more than 50 years since the Town and Country Planning Act 1947. In contrast, the planning systems of the new EU accession countries such as Bulgarian have undergone major change in recent decades. In Bulgaria, following democratic changes that took place in Eastern Europe in the 1980s, the centralised planning system was abandoned and it took some time for an alternative system to be developed in its place through the Regional Development Act 1999 and the Spatial Planning Act 2001.

Furthermore spatial planning has different meanings in different EU countries simply as a result of geography and population. What spatial planning involves clearly varies when we compare a densely populated and highly urbanised country such as England with Bulgaria with a small sparse population (Table 2 below). Terms used in relation to spatial planning such as 'region' and 'local' again have very different meanings depending on the geography, population and political and administrative arrangements in different countries.

Table 2:Population and density in Theseus countries

Theseus case study countries	Km^2 in thousands (a)	Population in millions January 1 2010 estimates (b)	Population density per km^2 (c)
Bulgaria	110.9	7.8	70
England	130.3	51.5	395
France (d)	547.0	62.6	114
Poland	312.7	38.1	122
Spain	504.9	46.7	92
Other Theseus countries			
Belgium	30.5	10.8	354
Germany	357.0	82.1	230
Italy	301.2	60.6	201
(a)Wikipedia apart from England: ONS; (b) Europe in Figures: Eurostat Year Book 2010; (c) Calculated from (a) and (b); (d) Metropolitan France			

CONTEMPORARY DEBATES ON SPATIAL PLANNING

Contemporary debates on spatial planning have focused on the four key issue discussed below.

The Fundamental principles on which spatial planning is based.

Here it is possible to identify three fundamental notions:

1. First, land use planning at its most basic embodies notions concerning the relationship between the state and the citizen, in particular citizens as land and property owners. The state at national, regional or local level through planning assumes powers to regulate the use of land and property. Planning, although it presents itself as a neutral, apolitical process is inevitably political reflecting changing political values and policies in particular the relationship between the public and private spheres as well as changing planning doctrines. This can be seen in the shifting objectives, processes, scale and scope of UK post 1947 spatial planning documented by Allmendinger and Haughton (2007) and is probably evident in other European countries. The political transformations, which took place in Poland after 1989, which led to a significant revision of the then existing system of spatial planning (BSR INTERREG PROJECT B III Project Poland undated) are another example.

2. Second, spatial planning in Europe according to the European Spatial Development Perspective (ESPD) (EC 1999) and other EU spatial planning initiatives is intended to support the three key objectives of the EU for economic and social cohesion, conservation of natural and heritage resources and a more balanced competitiveness across EU territory. It is also intended to

promote balanced and sustainable development. The extent to which these principles are embodied in EU member states' spatial planning and the enthusiasm with which they are embraced may vary. Certainly sustainable development: balancing economic, social and environmental concerns has been recognised as a guiding principle in UK spatial planning and remains so under the Decentralisation and Localism Bill 2010. Spatial planning thus essentially involves seeking a balance between competing interests, activities and actors.

3. Third, spatial planning in EU countries should be conducted according to the Aarhus Convention principles. European law makes the principles of 'good governance' that is openness, participation, accountability, effectiveness and coherence – a legal requirement for decision making. Thus spatial planning should involve not simply than information provision and formal consultation processes but also real engagement, deliberative processes and visioning involving a range of actors. The extent to which this principle is acted on in spatial planning in EU counties at different levels and circumstances and the effectiveness of engagement activities are issues issue that requires investigation at strategic and local levels. Allmendinger and Haughton (2009a) comment that advocates of spatial planning share a naivety about the nature of contested spaces and the role of planning. They argue that such advocates assume (and they are making an assumption here) that spatial planning if it is undertaken in an open, transparent, and collaborative way will lead to consensus and ultimately to better development. They note on the basis of their research experience that deliberation may ease tensions at the strategic document level, only for them to surface again at the implementation stage.

The scope of spatial planning

A second issue of debate relates to what is, or should be, the range of different sectors and interests involved in spatial planning and the extent to which spatial planning acts as an integrative process involving a range of actors and sectors. The shift in planning terminology in England from 'land-use planning' focused on the regulation of the use of land to 'spatial planning' was intended to signal a shift to a more all embracing form of planning involving the integration of a wide variety of policy sectors in relation to a given space or place: economic development, transport, the environment including the water environment, education, health, and their interactions. Spatial planning is not a precisely defined concept and has a variety of meanings and applications and this will be evident across Europe. For England, at least, some commentators (Allmendinger and Haughton 2009a; Kunzman 2009) have questioned the extent to which shift in terminology towards 'spatial planning' reflected a marked change in practice.

Scale issues in spatial planning

Linked to the issue of scope is the issue of scale. Here the debate centers on space or place, that is, the most appropriate territorial units for spatial planning and the relative importance and power of national, regional, sub regional and local level planning. Allmendinger and Haughton (2009b) argue that this does not simply involve a shift of emphasis across existing national, regional, sub-regional and local scales but an insertion of new scales for planning interventions initially at least through 'fuzzy boundaries. Such ‘soft planning’, they argue, is needed if planning is to reflect the complex relational world of associated relationships that extend across formal boundaries and involve a range of geographies. Formal planning has mainly taken place, and they concede, will continue to take place within regional or local administrative boundaries. However these boundaries may not be the most appropriate given certain physical, social and economic problems and opportunities affecting development. For example, at the coast, coastal cells might offer a better basis for planning and overcome problems of co-ordinating numbers of maritime local authorities. Certainly in the U.K spatial planning takes place beyond the formal spatial planning system and these other forms of spatial planning are likely to exist in other EU countries.

Systems, institutions and mechanisms for spatial planning

There is a huge diversity in the systems, processes and mechanisms used in spatial planning across Europe. Debates concern the ‘best’ approach for achieving spatial planning objectives. For example, whether rigid zoning or more flexible guidance is most appropriate and effective method for development management and control. Another example would be the mechanisms used to ensure conformity with plans and planning decisions: the planning system or the legal system.

COMPONENTS OF SPATIAL PLANNING : EXTENT AND TYPE OF PLANNING AT DIFFERENT LEVEL.

Despite variations, it is possible to identify common components of formal spatial planning systems across EU member states. It is important, however, to be aware that there may be significant informal spatial planning processes taking place as well as the formal ones. In almost all EU countries the following are to be found:

- International and Europe-wide planning
- National planning: at national level, a legislative framework, spatial plans or policies to guide lower level plans, strategies, or policies and decisions
- Regional planning: at regional level, spatial planning policies or plans to provide a reference for lower level planning and to co-ordinate inter-regional policy.
- Local planning: local level plans and policies relevant to the local area. All the Theseus case study countries have some spatial or development plans and planning at this level.
- Mechanisms for site specific land use regulation and for site specific decision making on spatial developments. Here there may be wide differences in what types of development or type of development in particular regions is regulated.
- Enforcement: mechanisms to ensure the compliance and enforcement of plans, policies and regulations at all levels. The mechanisms available for enforcement and compliance and extent to which the mechanisms are used may vary across case study areas.

Formal spatial planning is generally hierarchical and compliance with the policies and plans at the higher levels is usually a requirement at lower levels. However exactly how stringently this is applied will vary. The following sections will explore these components of formal spatial planning and their implications for planning at the coast.

International and Europe-wide influences on spatial planning

EU Directives and policies and international treaties relevant to spatial planning

There is as yet there is no Europe wide spatial planning law and spatial planning has remained within the competence of the member states. However (as outlined in section above) there has been a growing interest in spatial development planning within the EU. Furthermore there are many EU Directives and international treaties that are relevant and influential in relation to spatial planning in member states including spatial planning at the coast. Table 3 below presents some key examples. There are also many EU policies for example, policies relating to transport, agriculture, trade, industrial development, social inclusion and competition and energy policies that have an influence on spatial planning (Roberts and Beresford, 2003).

There are four EU policies that have particular importance for FCERM and spatial planning at the coast: the Floods Directive in relation to coastal flooding, the Water Framework Directive as it is related to coastal waters, the Marine Strategy Framework Directive and the Recommendations on ICZM. The mechanisms for, and progress in, implementing the Directives and in acting on the recommendations may vary across the member states.

The Marine Strategy Framework Directive (MSFD) has been the focus of recent policy development within and between member states where marine regions involve more than one member state (Douvere 2008). Marine spatial planning like spatial planning on land is seen as a tool for integrating and managing economic, social and ecosystem-based objectives for the marine environment. The Netherlands, Belgium (Douvere et al. 2006), Germany and the UK have all been active in developing marine spatial planning. In the UK the recently established Marine Management Organisation will take responsibility for the development of marine plans to guide decisions affecting the marine environment in England and for designating with environmental bodies Marine Protection Areas (Douvere 2008).

The extent to which, and the ways in which, these four planning processes have been or will be separated from or integrated with spatial planning for the land in each the EU member states is an issue that needs to be investigated. How the different policies are to be co-ordinated with each other is also unclear. The MSFD document (EC 2008) suggests that this Directive should be linked to the WFD and should cover the material not covered by the WFD on coastal waters. It does not specify the relationship of marine spatial planning to ICZM or spatial planning at the coast.

There is as yet no EU Directive on coastal erosion risk management akin to the Floods Directive although erosion is covered by the ICZM recommendations. The Eurosion Project (EC 2004) estimates that about 20% of the coast of member states is facing serious erosion impacts. The Eurosion study recommends that coastal erosion hazards and risk mapping should be incorporated into long term regional and local spatial planning so that development can be guided away from such risk areas.

The key EU directives are summarised below:

Key EU Directives and policies and international treaties relevant to spatial planning
Nature and heritage conservation • Ramsar Convention 1971 which designated wetland sites of international importance. Ratified in UK in 1976 • 'Birds Directive' (79/409/EEC) 1979; and its codification (2009/147/EC) establishes Special Protection Areas (SPAs). • 'Habitats Directive' (92/43/EEC) 1992 establishes Special Areas of Conservation (SACs) for animals, plants and habitats. • European Marine sites: the collective term for SACs and SPAs that are covered by tidal waters and protect specific marine and coastal habitats. • Bonn Convention 1979 on the conservation of migratory species came into force in 1983 • World Heritage sites (WHS): places of outstanding universal value. Only three in the UK relate to coastal environments: Dorset and East Devon Coast WHS 2001; Cornwall and West Devon Mining Landscape(WHS) and the Giants Causeway and Causeway Coast in Northern Ireland. • The Strategic Environmental Assessment Directive (SEA)Directive
Water and floods • Water Framework Directive (WFD) (Directive2000/60/EC) for improving the quality of water bodies through river basin planning. • 'Floods Directive' (Directive 2007/60/EC) 2007 to reduce the risks that floods pose to human health, environment, cultural heritage and economic activity through assessment, mapping and flood risk management in river basins and on the coast.
Coastal Management • In May 2002, the EU adopted a recommendation on implementing Integrated Coastal Zone Management (ICZM) in Europe, asking members to review legislation and the institutions and stakeholders involved in the management of the coast and to develop strategies for delivering ICZM. • Marine Strategy Framework Directive (MSFD 2008/56/EC) to achieve good status in the marine environment by 2020
Public consultation and engagement • UNECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters 1998 • Directive 2003/4/EC on public access to information • Directive 2003/35/EC on public participation in Environmental decision-making.
Other selected EU policies relevant to spatial planning • CEMAT Guiding Principles for Sustainable Development of the European Continent (2000) • Third report on Economic and Social Cohesion (2004), Fourth Report on Economic and Social Cohesion (May 2007). This included increased coverage of environmental issues and their impact on different regions and the impact of climate change.

The European spatial development perspective and its influence

The European Spatial Development Perspective (ESDP), the culmination of many years of informal discussion on Europe wide spatial planning (Faludi and Waterhout, 2002) was adopted in 1999 in Potsdam by the Ministers responsible for Spatial/Regional Planning in EU Member States. It represents a landmark attempt to develop a spatial planning approach at European level. It supports an integrated and multi-sectoral approach and balanced and sustainable development across the European territory. It is intended to meet the three fundamental goals of EU policy:

- Economic and social cohesion,
- Conservation and management of natural resources and cultural heritage,
- And a more balanced competitiveness across the EU territory.

There have been further steps in EU spatial development policy. A recent document, 'Territorial Agenda for the European Union: Towards a More Competitive and Sustainable Europe of Diverse Regions' agreed in Leipzig in May 2007 (European Commission 2007) updates the 1999 ESDP in the light of the EU enlargement of 2004 and 2007 to 27 members and emphasises strengthening territorial cohesion as a key task. It also seeks to increase the global competitiveness and sustainability of all regions in Europe. The guidelines of European spatial policy remain as in the ESDP:

- Developing balanced and polycentric urban system and a new urban-rural relationship.
- Securing parity of access to infrastructure and knowledge.
- Sustainable development and wise management and protection of natural and cultural heritage.

The key focus in European spatial planning is upon the region. The overall principle underlying the spatial policy appears to be to reduce disparities between regions within countries through policy for urban and rural areas. The aim appears to be to redress the 1999 situation in which the agglomerations of London, Paris, Milan, Munich and Hamburg accounted for 40% of population and 50% of EU GDP.

The concept of polycentric urban development has obtained widespread currency in debates among academics and professionals in planning and policy makers since the 1980s (Romein 2004). It has been defined by Ballinger 2008 (p.6) after Wiesbuch 2004 as follows:

'Polycentric spatial development promotes the establishment of multi-centred, balanced development foci as well as "dynamic and competitive cities and urbanised regions" and "indigenous development of productive rural areas" (Wiesbuch 2004). It also recognises the functional linkages between urban and rural areas and the role of urban clusters and gateways to achieving such balanced development'.

Thus the term 'polycentric urban system' appears to imply developing a number of linked urban centres within regions in EU countries and avoiding the concentration of development within one or more dominant urban centres such as the capital cities and improving the balance between regions within countries. This form of urban development has been contrasted with other theoretical urban spatial forms: the dispersed city and the compact or sustainable city (Salas Olmedo 2008).

The third element in the ESDP, 'wise management and protection of natural and cultural heritage' is highly relevant to coasts and Integrated Coastal Zone Management (ICZM) is noted as providing a way of managing the many challenges at the approximately 90,000 km of coast of the EU countries included at that time.

Although, a notable feature of EU spatial planning thinking is the focus on regions, another initiative which culminated in the Leipzig Charter, May 2007 focused on Sustainable European Cities recognising the importance of cities and their role for the overall economic development of the EU. This is based on the fact that currently over three quarters of the EU population live in towns and cities of more than 50.000 people. The recent report 'Follow-up of the territorial Agenda and Leipzig Charter: Towards a European Action Programme for Spatial Development and Territorial Cohesion' December 2007 (European Parliament 2007) provides an action plan to take forward the objectives of the two documents.

The ESPD and European spatial planning policy have generated a substantial academic literature and debate along three lines. Some critical discussion has focused on the content and process proposed in the ESPD and on its key proposal for the polycentric form of development (e.g. Richardson and Jensen 2000). There has also been consideration of the ESPD policy making process and on its political and institutional implications (e.g. Williams 2000; Faludi and Waterhout 2002). Further studies have examined European spatial planning in specific regional contexts (e.g. Tewdwr-Jones and Williams 2001; Janin Rivolin 2003)

Although the ESDP, has no binding legal status and the EU has no formal authority for spatial planning, many commentators believe that this document has influenced spatial planning in member states and has placed the co-ordination of EU spatial planning on the political agenda. For example, Roberts and Beresford (2003) and Allmendinger and Haughton (2007) note that the ESDP has influenced UK governments and has led a to strengthening regional planning in England, a shift which culminated in the introduction of statutory regional planning through Regional Spatial Strategies in the planning and Compulsory Purchase Act 2004 which abolished also the sub-regional level Structure Plans. The Planning Policy Guidance RPG11 Regional Planning (DETR 2000) makes specific reference to the ESPD. However, this development is to be reversed by the Coalition Government through the Localism Bill which will abolish Regional Spatial Strategies. The adoption of more integrated policy approaches in planning and the shift from narrow 'land use planning' to 'spatial planning' in 2004 in England can also be seen as deriving from the European policy. Others argue that the substantial differences in spatial planning traditions across member states and resistance to integration have limited the success of the initiative in developing a Europe- wide development perspective although the ESPD has undoubtedly had an influence on planning in EU countries (Rivolin and Faludi 2005). The future of certain key

European spatial planning policy ideas such as that of territorial cohesion remain uncertain given the bureaucratic politics of the EU and the different perspectives of member states (Faludi, 2000; 2002; 2007).

The ESPD and its implications for spatial planning at the coast

The ESPD's integrated and regionally focused approach appears to be well suited to, and supportive of, Integrated Coastal Zone Management (ICZM). Although the EU's work on ESPD and ICZM (the Commission's ICZM Demonstration Programme 1996-99; publication of the EU Strategy on ICZM, 1999; 2000) proceeded separately but in parallel, they have not been pursued in isolation (Kidd et al 2003). Furthermore, the concept of integrated action to achieve balanced and sustainable development is central to both the ESPD and ICZM. In May 2002, the EU adopted a recommendation on implementing Integrated Coastal Zone Management (ICZM) in Europe, asking members to review legislation and the institutions and stakeholders involved in the management of the coast and to develop strategies for delivering ICZM. The EU has now launched a review of the ICZM Recommendations with a view to a follow up proposal by the end of 2011. In 2010 the EU had taken a step forward in strengthening the legal framework for ICZM in the Mediterranean. However, the recommendations of 2002 propose ICZM as a process distinct from spatial planning and state that ' An integrated coastal zone management involves multiple factors among which town and country planning and land use are only accessorily concerned ' (European Parliament and Council 2002).

National spatial planning

This section considers some of the factors affecting spatial planning in EU countries at the national level.

Constitutional law and government structures

CONSTITUTIONAL LAW

Constitutional law is of interest in relation to spatial planning for two reasons. First, in some cases a county's written constitution defines individual or government rights or responsibilities, for example, the rights or responsibilities of governments or property owners in relation to land ownership and property. These rights and responsibilities in turn influence the organisation, priorities and operation of spatial planning. The Compendium (EC1997) cites the example of Netherlands and Spain, whose constitutions grant the right to a decent home for all citizens. This explains in part the importance attached in both countries to housing provision. In Italy, the constitution addresses the claim of all citizens to jobs and homes. In Germany, the constitutional principle of equal living conditions throughout the country is reflected in mechanisms for redistribution of resources between Lander. Constitutional law in the Netherlands goes further, requiring local authorities to ensure good living conditions and to protect and improve the environment (EU 1997) and of the constitutions of Finland and Portugal which effectively grants landowners the right to build on their land (EU 1997). The UK at the extreme has no written constitution and responsibilities are defined by legislation rather than a constitution.

A second issue is the structure government that the constitution establishes and how the constitution allocates responsibilities for spatial planning. Some countries have constitutions that do not contain provisions relevant to spatial planning. In the UK, with no written constitution, the form structure of government is established by legislation. For example, spatial planning has become the responsibility of the national governments of England, Wales¸ Scotland and Northern Ireland as a result of devolution through legislation.

GOVERNMENT STRUCTURES

Government structures vary across the EU and thence where spatial planning legislation can be enacted also varies. In unitary states, such as the Netherlands, Bulgaria, Poland and France the national government makes the law in relation to spatial planning although certain responsibilities may be delegated to regional or local government. In the UK, under devolution responsibility for spatial planning law and guidance rests with the national governments in England, Wales, Scotland and Northern Ireland. In the remainder of this report, the focus will be on England and its spatial planning.

At the other extreme are some federal states where power is shared between national government and another level , for example the Federal government and the 16 lander in Germany. In Belgium the national government has no explicit competence in spatial planning although the basic principles of the Spatial Organisation and Town Planning Act 1962 still apply. It can be argued that there is no national Belgian planning system but three independent systems in the geographic regions: the Flemish Region, the Walloon Region and the Region of Brussels-Capital are responsible via their regional governments and administrations.

In between, are regionalised countries such as Spain and Italy where power lies both with national government and with tiers below as determined by the constitution or legislation. These countries have strong regional structures and the regions have powers to make laws within the national government's legislation framework. In both Italy and Spain the autonomy of the regional governments vary from one to another. In Italy, five of the Regions have special status and more extensive powers to govern themselves. In Spain similarly there are four regions that have special status and wider powers. Thus in these countries the situation is very complex and depends on the particular region of interest (EC 1997). In Spain, the constitution provides for a quasi- federal system and for spatial planning to be the responsibility of 17 regions with their own planning legislation.

Table 3: National level: Spatial planning and flood and coastal erosion risk management: Key Agencies responsible

Belgium	None	None	None
Bulgaria	Council of Ministers (guiding principles for Spatial Planning); Minister of Regional Development and Public works (implementation) National Construction Control Directorate National expert board on spatial planning and regional policy	Two ICZM offices within the Ministry for Regional Development and Construction are responsible for coastal zone management implementation Also the Ministry of Environment and Water	Disaster Management Ministry
England	Department for Communities and Local Government (CLG) Planning Inspectorate	Department for the Environment Food and Rural Affairs Environment Agency Marine Management Organisation	Cabinet office Environment Agency
France	Interministerial Agency for Spatial Planning and Competitiveness (DIACT)	Secretariat General de la mer Minister of Ecology, Sustainable Development, Transport and Housing	The Ministry of the Interior, Overseas France, local authorities and immigration
Germany	Ministry of Transport, Building and Housing	Ministry of Transport, Building and Housing responsible for coastal planning issues	Federal Government: disaster management and civil protection agencies
Poland	Government Centre for Strategic Studies ; Housing and Urban Development Office	Coastal zone management: Maritime Office under Ministry of Infrastructure	Government Emergency Management Team
Spain	None	General Directorate of Coasts, Ministry of the Environment	*Information to be gained through case-study interviews*

The scope of spatial planning and co-ordination at national level.

The range of policy topics over which the spatial planning system has some competence or influence and the degree of integration between spatial planning and social, economic and environmental planning may vary. Austria, France, Germany, Finland and the Netherlands all display some features of integration while England has only relatively recently moved away from a traditional narrow 'land use planning to more broadly based spatial planning approach (EC 1997).

How responsibilities are divided between different departments or ministerial authorities at national level varies. In England, spatial planning is the responsibility of the Department for Communities and Local Government (CLG) while flood and coastal erosion risk management (FCERM) are the responsibility of another department, the Department for the Environment, Food and Rural Affairs (Defra) and the Environment Agency which has an overall supervisory role on flood defence. In many countries, responsibilities for FCERM and spatial planning are also divided between ministries and agencies (Table 4 below). This may make co-ordination at national level of spatial planning policy and coastal management policy problematic and may make it more difficult for national spatial planning policy to adequately address FCERM. However, in England, Defra 's strategy for flood and coastal erosion risk management , Making Space for Water (Defra 2004) and its follow up documents (Defra 2005, 2006) clearly recognise the importance of spatial planning to FCERM. Furthermore, CLG's spatial planning guidance documents on development and flood risk, Planning Policy Guidance 25 and Planning Policy Statement 25 and its supplement were drawn up in close consultation with Defra and the Environment Agency. Thus, institutional separation does not necessarily result in incoherent policy.

In France, the Minister of Ecology, Sustainable Development, Transport and Housing embraces many of the topics that are relevant to spatial planning: housing, transport and sustainable development but also the prevention of risks such as flooding. Spatial planning, however, remains the responsibility of DIACT.

Bulgaria appears to have the advantageous situation where offices with responsibility for ICZM are located within the Ministry with responsibility for urban and land use planning and development and construction on the coast. However, problems and constraints on the development of ICZM in Bulgaria such as insufficient and ineffective definition of responsibilities of state and other agencies and lack of co-ordination have been reported (Onderstal 2000).

National principles, policies and plans.

Most EU member states have some kind of explicit spatial planning policy statements at the national level. These provide a framework and general direction for plan making and regulation at lower levels. EU countries differ in the extent to which they set national level spatial planning principles, policies and guidance and in how detailed and prescriptive these may be.

Belgium as a federal country has no national instruments. In Spain, spatial planning is devolved to 17 regions that produce their own policies and plans. The German Federal government confines itself to setting out national principles and broad policies.

Planning at national, regional and local level in EU countries is constrained by international treaties and by EU designated sites (see above). In addition national governments and national conservation and heritage bodies may confer national designations to protect areas that have particular value which then place special restrictions on planning and development within them both at regional and local levels. For example, in England the Marine and Coastal Access Act 2009, established Marine Protection Areas covering, coastal SACs and SPAs established by EU Directives, Ramsar sites, nationally designated

Sites of Special Scientific Interest (SSSIs), and new Marine Conservation Zones. In addition there are national landscape designations: Areas of Outstanding Natural Beauty (AONBs).

Table 4: Spatial planning principles, plans and policies

National level	State	Spatial planning principles, plans and policies
Belgium	Federal	No national spatial planning principles, policies or plans as spatial planning is devolved fully to it three regions (Flemish, Walloon and Brussels-Capital)
Bulgaria	Unitary	The Spatial Planning Act 2001 sets out the principles and processes of the planning system. A national Integrated Development Scheme which specifies how national planning objectives may be achieved
England	Unitary	There is no national spatial plan. But national Planning Policy Statements (PPS) and Guides set out the arrangements for the planning system and for specific policy areas including development and flood risk (PPS25) and the coast (PPS25 Supplement).
France	Unitary	National Schemas de Services Collectifs (SSC) covering 8 topics, culture, health, education, information, transport, energy, sport and natural and rural areas
Germany	Federal	Federal Republic does not produce a comprehensive, legally binding national plan but confines itself to setting out fundamental principles (Leitbilder) for spatial planning (raumordnung) and spatial planning policy in Germany in A 'Raumordnungspolitischer Handlungsrahmen.
Poland	Unitary	Outline of the national policy of spatial (physical) development: a strategic and open document and planning process through which a document: Spatial Development Policy is produced and amended. The policy covers all Poland divided into regions.
Spain	Regionalised	No national plan or policies: spatial planning is the responsibility of the autonomous communities.
Italy	Information on Italy is still being sought and will be included in final THESEUS reports	

The following sections illustrate some of the linkages between national spatial planning policy and FCERM for two countries: England and France.

ENGLAND

In England, the trend over the past 30 years, since 1982, has been for national planning policy guidance to become more detailed and prescriptive and thus for the balance of power between central and local government to shift in favour of the centre while in France the movement has been towards deconcentration and decentralisation (Pottier et all 2005, Diact and the General Directorate of International Cooperation and Development at the Ministry of Foreign Affairs 2006). However, with the new Coalition government in England with its commitment to localism, this trend is likely to be reversed with more emphasis on local plans and decision making and less central government regulation. At present, England does a not have a national spatial plan. Wales does have such a document, the Wales Spatial Strategy. However, the Coalition has announced its intention to consolidate the existing twenty or more planning policy statements (PPSs) and guidance documents into a single concise National Planning Policy Framework for England. The Coalition Government retains decision making powers over nationally significant strategic infrastructure such as energy, waste, road, rail and water projects some of which may be located at the coast. National Policy statements covering nationally significant structure including ports, waste water and energy are being produced.

Central government in England has issued two PPS documents that are directly relevant to FCERM. These documents have been produced by the Department for Communities and Local Government (CLG), which is responsible for spatial planning but in consultation with, and with a considerable input from the Environment Agency (EA) and the Department for the Environment Food and Rural Affairs (Defra) which have FCERM responsibilities and other stakeholders. These documents provide very detailed and specific guidance on the policy and through their Practice Guides on its implementation.

PPS25 on Development and Flood Risk (PPS 25: CLG revised March 2010 and Practice Guide: CLG March 2010):

- covers all forms of flooding: tidal, coastal, fluvial and surface water;
- it sets out a sequential approach to flood risk that should be applied at all levels of planning: regional and local plans and to site specific planning applications. Through the sequential approach, development should be directed first towards low probability areas and away from areas of high probability and only if no areas of low probability are available should areas of higher probability be considered;
- it embodies a risk-based approach embracing both the probability of flooding and the consequences. Probability is defined in three main zones, low, medium and high probability. Consequences are addressed through a five group classification of vulnerability according to land use types;
- It allows flexibility by providing an Exception Test to be applied after the sequential test has demonstrated that no low probability sites are available. For the Exception Test to be passed it has to be demonstrated that the development has sustainability benefits that outweigh flood risk considerations, that the site uses previously developed land wherever possible and that a flood risk assessment be carried out for the site to show that the risk can be managed and the development made safe via emergency and evacuation plans without increasing the risk elsewhere;
- It requires a flood risk assessment of appropriate scale to be carried out at all planning levels: regional, local and for individual site development proposals.

The PPS25 Supplement: Development and Coastal Change places a new requirement on maritime local authorities to ensure that policies and decisions at the coast are based on an understanding of coastal change over time. The objectives of this policy are to prevent new development being put at risk at the coast by: avoiding inappropriate development in vulnerable areas and development that will add to the impact of physical change; to direct development away from areas vulnerable to coastal change and where exceptionally development is necessary because it needs a coastal location and provides substantial social and economic benefits to communities; to ensure that the risk to the development is managed over its planned lifetime.

Local planning authorities are required to:

- ensure an evidence base on coastal change drawing on Shoreline Management Plans (SMPs), EA data and maps, strategies and other plans such as Estuary Management Plans while taking wider social, economic and environmental policy objectives into account;
- take into account the strategic approach in the Regional Strategy and other strategic plans relating to the coast; and work in partnership with other local authorities and agencies;
- through these processes, identify Coastal Change Management Areas (CCMAs);
- specify the type of development appropriate for the CCMAs and the circumstances in which certain types of development may be permissible with the CCMAs;
- where development and infrastructure needs to be relocated from within CCMAs, local authorities should make provision for sufficient land to be made available outside the CCMAs.

The document also specifies a regional planning approach and how coastal change should be addressed in Regional Strategies. However, given that Regional Strategies are no longer to be produced, the regional dimension of the policy is no longer effective.
The document also provides development management policies indicating how site specific planning applications in CCMAs should be considered by local planning authorities:

- Planning applications within CCMAs should be accompanied by an assessment of vulnerability proportionate to the vulnerability and scale of impact;
- Applications for development (including time limited development renewals) in CCMAs should be considered appropriate where: vulnerability assessment shows that development will be safe over its planned lifetime, and will not impact unacceptably on coastal change; where the character of the coast including designations will not be compromised; where the development provides sustainability benefits and does not interfere with coastal path routes.
- Developments deemed appropriate in CCMAs should be time-limited, taking account of the vulnerability assessment and with planning conditions imposed to ensure that the risk is managed and the removal of development is managed to minimise the impact of community and natural and historic environment.

Currently, through this document and its practice guide, spatial planners in England have been given a central role in managing change at the coast. It not clear whether and in what form PPS25 on Development and Flood Risk (CLG 2006; revised March 2010) and its Supplement on Development and Coastal Change (CLG 2010) will continue after the Coalition government's review of planning policy.

Central government has a mechanism, the Planning Inspectorate for England and for Wales, to ensure that local planning authorities comply with its national policies and guidance. This body, a non-departmental government body examines development plan documents and hears appeals against the rejection of planning applications and one of the key factors that it considers is whether the plans or decisions are consistent with national policy. Government Offices in the administrative regions in England also advise and exert influence on local authorities in their planning.

Although spatial planners have a key role in relation to flooding and coastal change, the evidence on coastal changes on which their plan-making and decision-making depends is generated elsewhere through SMPs, Strategies, Estuary Management Plans and other informal planning processes at the coast. SMPs have been produced in England and Wales since the 1990s. The EA with local authorities manages the physical risks of both coastal erosion and flooding through its strategic oversight for the production and quality of SMPs. These provide a large scale assessment of the physical risks associated with coastal processes and present a long term policy framework on how to reduce the risks to people and the natural and historic environment. A total of 22 second generation SMPs are to be produced for England and Wales. The EA works with groups of coastal local authorities and other key stakeholders and in consultation with local communities to produce these plans. Early SMPs have been criticised for the limited way in which local communities were engaged in their production.

Defra's initial policy development document 'Adapting to Coastal Change: Developing a Policy Framework (Defra March 2010) clearly recognises the importance of spatial planning to managing change at the coast , indicating in this instance, a well coordinated approach. In December 2009 Defra selected 15 coastal local authorities to act as pathfinders to explore a range of approaches to engaging with communities, helping them to plan coastal change, and to maintaining community vitality through for example roll back schemes, relocation, buy to let schemes and capital projects that allow for continued enjoyment of changing coasts over a specified time period. This Pathfinder project is an example of a central government initiative to find new ways of adapting to coastal change. But it will rely very heavily on the innovative ideas on adaptation and resilience provided by the local participants when the project concludes in Spring 2011.

FRANCE

France has had a tradition of a highly centralised spatial planning system but since the 1980s has changed its system significantly and adopted a more flexible and decentralised approach , transferring powers from central government to lower levels through the legislation of March 1983, March 2003 and the Decentralisation Act of August 2004.

The Spatial Planning and Development Acts of 1995 and 1999 developed new planning tools. At the national level, Public Service Plans (Schemas de Services Collectifs: SSC) were instituted. These set guidelines until 2020 for policies on higher education and research, culture, information and communication, energy, conservation of natural and rural areas and sports. New guidelines on transport to 2025 have also been provided.

In spatial planning terms, France's coastal zones present particular challenges since these areas have attracted growing populations in the last 30 years and at the same time are exposed to significant risks: shoreline erosion and retreat, dune migration and flooding. A 1982 law established the principles of obligatory insurance (CatNat) and national solidarity for natural disasters in France. This law is invoked when a natural disaster is declared by the appropriate authorities. The 1982 law also established Predicable Natural Risk Exposure Plans (PER) which were supposed to forbid construction in the zones most exposed to risk. However in the mid 1990s the implementation of these tools to control development in areas at risk was evaluated and found to have had negligible impact in coastal areas. The Barnier law 1995 established the Predictable Natural Risk Prevention Plans (PPRn). The PPRn procedure is set out in two national government decrees of 1995 and 2005. The PPRn are planning documents that establish three zones in coastal areas with land use and construction regulations that depend of the intensity of the natural hazard: flooding and coastal erosion chiefly. In one of the three zones, construction is forbidden. The PPRn are attached to the local zoning plans that regulate the use of land. By 2007, 270 coastal communities or about 30% had approved PPRns (Deboudt 2010).

The Barnier law also included a new option for managing natural risks: retreating from exposed areas and abandoning property through expropriation and indemnifying inhabitants if lives were threatened and defence would be more costly than expropriation. Property evaluations are calculated on the basis of equivalent property not in an area exposed to risk. This option only applies to cases affected by shoreline retreat and landslides affecting coastal cliffs and not to flooding. This expropriation procedure was used at the end of the 1990s to buy out dwellings on a cliff edge in Criel-sur-Mer, Seine-Maritime (Deboudt 2010)

Partly as a result of encouragement of moves towards ICZM by the EU, in 2004 France established some specific measures to reactivate and redirect its policy for coastal areas towards an ICZM approach. In 2005 25 coastal sites were selected through a central government call for pilot projects to trial an integrated approach to coastal zone management. A national advisory board, the National Coastal Council made up of coastal stakeholders was also set up in 2005.

Regional spatial planning

The ESDP and European spatial planning policy have a strong focus on planning at regional level. This is reflected within most European countries and in all the 5 Theseus case study areas apart from England. Regional planning is an important part of spatial planning. Many countries not only have regional planning but also sub-regional planning as well (see Table 5 below).

ENGLAND

England under the Coalition Government is out of line with much of Europe. In its 'Decentralisation and Localism Bill' published in December 2010, the government plans to reverse the policy for statutory regional spatial planning introduced in 2004 in the Planning and Compulsory Purchase Act of 2004. Under this, Regional Spatial Strategies (RSS) were produced by nine English Regional Planning Bodies including London. This strategic level planning will no longer take place when the new legislation is enacted in England's eight regions, although the intention is that there should be some voluntary grouping for planning purposes. London, however, will continue to produce a strategic London Plan. There is also no longer any general formal spatial planning at sub regional level as county Structure Plans were abolished under the planning act of 2004.

The process of creating RSS has been criticised as cumbersome and the outcomes have attracted criticism from local authorities and communities as out of line with local aspirations (House of Commons Select Committee on Communities and Local Government 2011). The Coalition Government has argued that regional planning creates an unnecessary layer of bureaucracy. However, the abolition itself has been criticised as creating a planning void and the need for a strategic level of planning above the local level has been strongly asserted (House of Commons Select Committee on Communities and Local Government 2011).

As part of the RSS process, regional planning bodies were required to produce Regional Flood Risk Appraisals which embodied a strategic overview of flood risk within the region in relation to river and coastal flooding. RSS also contained regional policies on flood risk which were important because local authority policies and plans had to be compliant with the policies within the RSS.

At the coast in England and Wales, the need for a strategic approach to coastal change and other coastal issues has long been recognised and 16 non-statutory groupings based on coastal cells were established for England and Wales in the 1980s. These have been replaced by 7 bigger non-statutory strategic coastal groups in England. The intention is that the groups should have a stronger role in the future planning for FCERM (Environment Agency 2008). Their role is stated as to provide a source of expertise on the coast and to advise the EA and Regional Flood Defence Committees on coastal matters including advice on the leadership of SMPs. Their membership includes representatives from maritime local authorities, port authorities, Natural England (for nature conservation), the EA and other key bodies. It is possible that these groups, together with SMPs and other sub-regional coastal management groups such as estuary management planning groups will go some way towards providing a regional perspective on coastal issues for local authority spatial planners.

SMPs and other non-statutory plans for estuaries and coasts had been seen as feeding into and providing the evidence base for both RSS and local level spatial plans.

Table 5: A guide to regional level spatial plans and policies

	Regional level /Sub-regional	**Plans and policies**
Belgium	3 autonomous regions	Flanders: Flemish Regional Structure plan and Flemish regional implementation Plan Wallonia: Walloon regional structure plan regional urban ordinance, Wallon sub-regional Plan Brussels: Regional development plan; regional destination plan; regional spatial ordinances.
	Flanders 5 provinces	*The only autonomous region with a coastline*
Bulgaria	6 Regions	*Information to be gathered during case-study interviews*
	28 Districts	District Development schemes
England	9 former Regions	Regional spatial strategies no longer to be produced in 8 regions
	32 English county councils	The only county council spatial planning responsibilities since the abolition of structure plans in 2004 are for minerals and waste plans
France	22 Regions	Regional Spatial Planning and Development Scheme (Schemas Regionaux d' Amenagement et de Developpment du Territoire (SRADT)) for a 20 year period
	96 Departements	*Information to be gathered during case-study interviews*
Germany	16 Lander	Regional development plans (landesentwicklungsplan/programme)
Poland	16 Regions	Two different processes and documents: Strategies for regional development and regional spatial development plans
Spain	17 Regions	Regional planning (Planeamiento territorial)
Italy	Information on Italy is still being sought and will be included in final THESEUS reports	

OTHER THESEUS COUNTRIES

In France, regions are a relatively recent local government unit, instituted by the decentralisation legislation of the 1980s. The Regions are responsible for producing Regional Spatial Planning and Development Blueprints or Schemas Regionaux d' Amenagement et de Developpement du Territoire (SRADT). These set out the basic guidelines for sustainable development in the region in the medium term. They are intended to shape the contracts between central and regional government.

The contractual approach is a critical tool for implementing spatial policy in France. There are Planning contracts between central government and regional governments which outline agreed strategic priorities for spatial planning and development in the region and resources needed. The most recent contracts for 2007-2013: Contrats de Projets Etats-Regions (CPER) focus on three priorities: local competitiveness and attractiveness, the environmental dimension of sustainable development including natural risks and social and territorial cohesion (DIACT 2006).

In Germany, the national spatial planning principles are translated by the 16 federal states or lander into regional development plans, or Landesentwicklungsplan/programm(LEP/LEPpro. Lander level Regional development plans are legally binding on all lower planning bodies. The Lander or state level regional plans cover issues such as the desired settlement structure, open space and its protection, and infrastructure: transport installations, public utilities and waste disposal. The Lander have established a variety of arrangements for spatial planning at sub-lander level. For example, Bavaria has 18 planning regions, whereas Hesse has only three and regional plans are produced by these sub-state level bodies.

In Poland too, regional governments have an important role in spatial planning. Legislation requires two different processes and documents: regional strategies and regional plans. The plan for spatial development of a region should cover: spatial development and settlement, infrastructure, natural and cultural environments, balancing regional and local requirements and agreed social objectives and directions of development.

The three Belgian autonomous regions have their own forms of spatial planning documents. Flanders' Regional Spatial Structure Plan (Regionaal Ruimtelijk Structuurplan Vlaanderer) and Regional Implementation Plans (Regionale Ruimtelijke uitvoeringsplannen). The Structure Plan sets out a vision for the region and aims to create a coherent and coordinated plan for all regional spatial initiatives. The Regional Spatial Implementation Plan sets out procedures for implementing the Structure Plan. Flanders also has provincial level structure plans and destination plans.

In Bulgaria, under the Spatial Planning Act 2001, 28 districts were given responsibliity for producing District Development Schemes. These were to cover the general spatial structure of the region, the location and future development of human settlements and infrastructure of national and regional importance and measures to protect the environment and for the prevention and mitigation of environmental damage and public health impacts (Bulgarian National Centre for Regional Development, undated). However, the Regional Development Act 2004 instituted 6 large planning and statistical regions in line with EU policy. Boundaries to these regions were changed slightly under a new Regional Development Act in 2008. It is not clear what progress has been made on regional spatial planning within the districts or the 6 regions.

In Spain, where spatial planning is the responsibility of the 17 regions (Autonomous Communities), each region has its own detailed planning legislation. Regions produce regional plans (planeamiento territorial) that are legally binding in a plan-led system. The respective regional government's legislation and plans at regional and lower levels classify all land as one of three categories:

- Urban land (suelo urbano)
- Developable land (suelo urbanizable)

- Land unsuitable for development (suelo no-urbanizable)

The definition of the third category is complex and contentious and has been subject to recent legislative change. Some land falls into this category because it has special environmental, cultural, heritage, or landscape value that demands special protection. It is not clear whether flood and coastal erosion risk play any part in the designation of land as unsuitable for development (Burns 2000, 2010).

Local level spatial planning

Land and property owner rights.

At all levels, spatial planning is a process that involves restrictions and constraints on property and land owners' rights. However, it is at the local level that this is most apparent because local policies plans and planning constraints may apply to specific sites and affect specific owners of property and land. Underlying the arrangement in different countries are different conceptions of property rights. In EU countries current land and property rights are established by law reflecting different conceptions of property rights. In most EU countries there are long established systems for registering and documenting land ownership. In some countries, for example Bulgaria, property rights have undergone recent changes following the break-up of the Soviet Union and legal processes for the restitution of land to former owners.

Land and property owner rights, depending on the law of a country, usually include the following: the right to occupy, use and enjoy property, to transfer, inherit and sell, to develop, change or improve, to cultivate and produce, to restrict access to others and to access services. Land and property ownership may also involve obligations, for example, the obligation not to harm others (Payne, 2004). Spatial planning most commonly may constrain the right to develop and change land and property through new or extended building or adaptation to buildings. It may also affect change of the use of land or property. The extent to which spatial planning impacts on property rights will depend on the specific provisions of the planning system.

In England, when the current planning system was instituted in 1947, it was recognised that planning took away property rights from owners and it was felt that these rights should only be restricted in limited circumstances. From this it followed that the specific circumstances in which planning permission should be required were defined. In other countries, broad zoning arrangement and associated regulations specify what development or use may take place within zones in development plans or regulations. In a third arrangement certain categories of land and property may be declared free from planning regulation, for example rural property.

Local level spatial planning.

Key documents consulted for this review (EC 1997) indicate that in all the EU Theseus countries, and indeed in all Europe (EC 1997), local authorities have key responsibility for local development planning and the major responsibility for land use change and building control. This responsibility is under the general supervision of the regional and national authorities and in relation to their plans and policies.

However, defining what is 'local' is challenging: the number, size and type of the local authority units which undertake spatial planning at the local level vary greatly across the Theseus countries (Table 6 below). The geographical areas and populations covered by the local plans and planning activities are diverse and varied within as well as between countries.

In all the EU and Theseus countries, there are two distinct spatial planning processes that take place at local level:

- production of local spatial development plan documents;
- the management and control of development through building permits and planning permissions.

LOCAL DEVELOPMENT PLANS

According to EC (1997), most European countries and many of the Theseus countries have two forms of local plan. First a general or framework plan for guidance on long term goals, future settlement patterns and major infrastructure and a link with regional and national guidance. These plans usually cover the whole local authority area. They are mostly legally binding. Second, regulatory plans that may cover the whole or part of the local authority area, indicate detailed specific zonings for buildings, land use and infrastructure, and grant the right to build or change land use through permit procedures or more detailed implementation plans. In addition, there are detailed building control instruments of various kinds.

In most cases local level plans have to conform to higher level plans and national policy and guidance. However the mechanisms and efficiency with which this conformity is enforced vary. Plannning also varies in the extent to which there is public engagement in the planning process. Planning legislation in England ensures that a substantial programme of consultation takes place. In other countries consultation opportunities appear to be more limited.

In addition to the formal local development plans required by law and undertaken within administrative boundaries, local planning authorities and others may group together to develop other forms of spatial planning and plans. These informal groups are not tied to administrative boundaries or formal procedures at sub-regional, local or neighbourhood level. The spatial planning for the Thames Gateway Growth area in England has been cited as an example of this new 'soft ' planning approach operating across administrative boundaries with a focus on coordination, integration and inclusion (Allmendinger and Haughton 2009). Other examples of this 'soft' planning approach may exist in the Theseus countries.

This review has found that some Theseus case study countries take measures to ensure that natural hazards such as flooding and erosion at the coast are addressed in the plan making process: England, France and Bulgaria. It is likely that other case study countries do so too but the review did not access any evidence of this.

Table 6: Local authorities and local spatial plans in WP case-study areas and other Theseus countries			
Local level	**Type of authority**	**Av. pop. estimated**	**Local spatial plans**
Bulgaria	263 Municipalities, 5333 settlements inc. 242 towns	30,000	General development plans of municipalities or towns. Detailed development plans
England	326 local authorities	158,000	Local Development Frameworks - LDF. Supplementary Planning Documents
France	36,778 Communes: Most are grouped for planning purposes		Local urban plans (Plan Local d'Urbanisme – PLU) Territorial Cohesion Plans (Schemas de Coherence Territoriale – SCOT)
Poland	2,489 communes		Local comprehensive planning document Development plans
Spain	8,000 Municipalities	5,300 *To be confirmed*	Local Development Planning: Local plans(Planeamiento general) municipal) and other detailed local plans e.g. partial, special plans (planeamiento derivado or de desarrollo)
Germany	12,000 Municipalities (Gemeinde)	6,800	Two phase urban land use planning: Preparatory land-use plan (Flaechennutzungplan) Legally-binding land use plan (Bebauungsplan)
Italy	8,100 Comuni	7,000	General Regulatory Plans (Piano regolatore general) and plans that cover part of the local authority area
Belgium	Flemish Region: 308 Municipalities Walloon Region : 262 municipalities Brussels Capital region: 19 municipalities	17,000	Municipalities in the different regions produce different types of local plan
Figures must be treated as approximate. Data compiled from different sources with various dates . (1) National Centre for Regional Development undated (2) Office of National Statistics 2010 (3) DIACT and DGCID 2006 (4) Lendzion and Lokucijewski undated;			

DEVELOPMENT MANAGEMENT

Development management and control is a process that imposes restrictions and constraints on what property and land owners can do in terms of development and use of their land. In some countries this is largely achieved through regulatory plans and zoning in development plans.

The Compendium (EC 1997) found a high degree of similarity in the way the then Member States (i.e. excluding Bulgaria and Poland) regulated building and land use change through a system of building permits. It also noted some similarity in what is subject to control: main building permits in most cases cover new construction, extension or demolition of buildings, building regulation, change of use or subdivision of land or buildings. There are differences particularly in terms of the extent to which minor building works and extensions are regulated. In Spain, for example, control can be exercised over very detailed matters (EC 1997). In all countries there are some general exceptions from planning control and these tend to be for agriculture and forestry (EC 1997). For example, in Bulgaria, within rural areas outside the boundaries of human settlements, it is permissible in certain circumstances to build agricultural buildings, industrial and warehouse structures and other infrastructure (Bulgarian National Centre for Regional Development, undated)

There is a range of other building permits that may be required in relation to building and change of use in the different EU countries. In Belgium, France, Germany and Spain, it has been possible to apply for a preliminary permit to establish the principle of the conformity of a proposed development to the plan in advance of applying for a building permit. In England it is possible to apply for outline planning permission to determine whether development is acceptable in principle.

Most applications for building permits are determined at local level by local politicians. Under what is called the 'plan led system', applications are examined for conformity to the local regulatory development plan, where such plans are binding and where a plan exists (EC 1997).

There are variations in who may appeal or challenge a planning application, to whom the appeal is made and on what grounds the decision may be challenged in different EU countries. Commonly appeals are made to the courts or to a higher level authority, although this may vary depending on whether appeals are made on substantive grounds relating to policy or facts (this could be on the extent of flood or erosion), legal or procedural grounds (EC 1997).

The following sections provide details on the two processes of local plans and development management and control in England and then consider local spatial planning in a range of Theseus countries.

ENGLAND

In England the two spatial planning processes are undertaken by separate specialised groups of staff within planning. The policy planning staff develops local plans and the development management staff is responsible for considering site specific planning applications.

Local authority development plans

In recent years, the national government in England has been active in seeking to ensure that flood risk and change at the coast were sufficiently taken into account by local authorities in their development plan-making through detailed guidance rather than a simple zoning approach. Formerly local authorities had to ensure that their development plans were consistent with the RSS for their area and with any FCERM policies or areas at risk presented in the RSS. With the abolition of the regional plans, national government guidance and policies are the only guide for the local authorities.

The various local authorities in England: that is Metropolitan District Councils, that cover large urban areas, Unitary Authorities and District Councils, are required by the Planning and Compulsory Purchase Act 2004 and by central government guidance, PPS 12 (CLG 2008) to produce local plans called Local Development Frameworks (LDFs). These involve a set of Development Plan Documents (DPDs) with key documents covering the whole of the local authority area for a 15 year period. The key DPD is the Core Strategy, which covers strategic objectives and primary policies which may include policies on flood and erosion risk. Another key document is an Adopted Proposals Map. PPS12 states that this map should identify areas of protection, such as nationally protected landscape and internationally, nationally and locally-designated areas and sites, and Green Belt land, as well as show areas at risk from flooding. The proposals map should also show sites allocated for particular land use as well as development proposals included in any adopted development plan document, setting out the areas to which specific policies apply. Flood risk areas are identified from the maps provided by the EA. The EA has to be consulted on drafts of DPDs and this is another mechanism which facilitates FCERM issues being taken into account in plan making.

DPDs have to be developed in accordance with national government guidance, that is, PPS 25: Development and Flood Risk and the PPS 25 supplement: Development and Coastal. PPS 25 requires local authorities to produce a Strategic Flood Risk Assessment (SFRA) for the whole local authority area drawing on maps and modelling provided by the EA and other sources, and in some cases on modelling undertaken specially for the local authority. PPS25 Supplement: Development and Coastal change gives very clear guidance through specific plan-making policies to ensure that coastal change is adequately addressed and Coastal Change Management Areas identified where appropriate in local plans.

The national Planning Inspectorate reviews local authorities' DPDs and finally subjects them to a formal hearing, an 'Examination in Public'. Inspectors will reject documents as 'unsound' if they do not comply with national government policy and guidance (e.g. PPS 25 and its supplement); if they do not have a robust evidence base (e.g. an acceptable SFRA and information on coastal change) and if they are not deliverable and capable of being monitored. All these requirements are intended to ensure that flood risk and change at the coast are adequately addressed in local plan-making.

The LDF plan-making process has been criticised as over prescriptive, cumbersome and time consuming. It is not as yet clear whether, and how, the Coalition Government will respond to these criticisms. Certainly, some local authorities have struggled to produce acceptable documents and many councils have still to complete their plan-making. This means that decision-making on specific planning applications has to be undertaken without the benefit of an up to date development plan. It will also take local authorities some time to meet the relatively recent requirements to address coastal change in the PPS25 supplement (CLG 2010).

Neibourhood planning

The Decentralisation and Localism Bill 2010 proposes a new sub-local authority level for planning in England: the neighbourhood level. Under the Bill either parish councils, the lowest level of local government in England with limited powers, or neighbourhood forums will be able to draw up Neighbourhood Development Plans for their part of the local authority area. Provided that the neighbourhood plans conform to national planning policy and are compatible with the local authorities strategic plans and with legal requirements, local people will be able to vote on the plan. If it receives majority approval in the neighbourhood, then the local authority will bring it into force. Local authorities will be required to provide technical assistance in planning matters to the neighbourhood groups.

In addition neighbourhood groups would also be able to grant full or outline planning permission in areas where they want to see new homes and businesses, making it easier and quicker for development to go ahead.

These proposals have yet to become law and to be implemented. There is as yet no clear definition of what will constitute a 'neighbourhood' for planning purposes. PPS25 and its supplement will apply to Neighbourhood Plans as they do to higher level plans and therefore it does not appear likely that they will have a significant impact on FCERM. However, the existence of neighbourhood groups and Neighbourhood Development Plans could make the task of coordination at the coast more difficult.

In addition to formal statutory spatial plans, English local authorities are required to develop and publish a Sustainable Community Strategy. This sets the overall strategic direction and a long term vision for the economic, social and environmental well-being of the area over a period of 10 to 20 years. This process is usually undertaken by the local authority in collaboration with the Local Strategic Partnership (LSP). This is a non-statutory body that brings together the different parts of the public, private, voluntary and community sectors, working at a local level. The lead organisation in the LSP is the local council. Other participants will include the police and the health services. The Sustainable Community Strategy is intended to feed into and to help shape the Core Strategy in the LDF, the local development plan and other sub-regional plans. This form of community network, bringing together the local authority with others from the community and from other public bodies and professionals networks, may also exist in other European countries.

Development management

In England, the Town and Country Planning (General Permitted Development) Order 1995 defines what kinds of development require planning permission from the local authority. In February 2008, this Order was amended to require planning permission for impermeable paving front gardens of 5m2 or more to reduce the risk of flooding due to surface water run off. Since the 1990s, England has operated a 'plan-led' system in which site specific planning decisions are required to be in accordance with the development plan unless material considerations indicate otherwise. If there are strong flood risk policies in the development plan to guide development away from flood risk areas, and appropriate development plan land allocations that have regard to flood and coastal erosion risks, then this should ensure that applications for development take account of such risks. However, the lack of an up to date adopted development plan does not prevent planning applications being considered and development taking place.

There are other mechanisms to ensure that flood risk is considered in planning decisions. Developers are required by PPS25 to submit a site specific Flood Risk Assessment (FRA) showing: whether the proposed development is likely to be affected by current or future flood risk; that the development will be safe and where possible reduces flood risk overall; whether or not it increases flood risk elsewhere; and showing how flood risk can be managed to make the development safe in its life-time. Designs that reduce flood risk on site and elsewhere, or which build in flood resilience, are favoured in the guidance.

The EA is a statutory consultee on all development applications apart from very minor ones in medium and high probability flood risk zones and advises all parties on flood risk. It can object to applications on flood risk grounds but the final decision on development rests with the local authority. Most commonly, the EA will engage in discussions with the developer and the local authority to see if it is possible to address the flood risk via redesign but time pressure on all parties often limits the opportunities to achieve optimal solutions.

The Flooding Direction (CLG 2007), a recent regulation for England, specifies that where a local authority is minded to allow a non-minor development in an area of medium or high probability flood risk, national government can be called upon to intervene and has power make the final decision. The Direction is intended to ensure that all parties make an effort to negotiate and resolve flood risk problems. Developers whose planning applications are refused can appeal against the decision. Appeals are decided by an Inspector from the national Planning Inspectorate. In the great majority of recent appeal cases in which the EA had sustained objections on flood risk grounds, the appeals were either dismissed or allowed with conditions fully mitigating the EAs concerns (EA 2010).

Thus, there are a range of mechanisms in place to ensure that flood risk is adequately addressed in spatial planning decisions in England. Monitoring shows that in most decisions where the EA objected on flood risk grounds, decisions were taken in line with the EAs advice. However, many cases involving flood risk were resolved via negotiation and compromise and there are examples of cases were sustainability objectives outweighed considerations of flood risk (Tunstall et al 2009; Pardoe et al, in press). Furthermore, under the localism policy of the Coalition government, the EA is being encouraged to confine itself to an advisory role only and to leave decisions to the local authority.

A similar approach is being developed to address risks associated with change at the coast. Under PPS 25 Supplement: development and coastal change (CLG 2010), planning applications for development in designated Coastal Change Management Areas (CCMAs) will require special measures. Applications will have to be accompanied by an assessment of the vulnerability of the development to coastal change and any impact on coastal change. The assessment should be proportionate to the vulnerability and scale of impact. The PPS provides detailed policy principles to guide consideration of applications for developments in CCMAs (CLG 2010).

FRANCE

Develoment plans

Communes produce local plans - Plan Local d'Urbanisme (PLU). However as they are very small units, a majority opt to work co-operatively in certain areas including local spatial planning. There are various structures for cooperation between communes: Public Corporations for Cooperation between Communes (EPCI) (DIACT and DGCIP 2006). The PLU will establish planning zones for the area, the planning rules that will apply to new development, and information on major development constraints. The preparation of a PLU takes place in consultation with all the relevant statutory bodies. It is not clear how much public consultation and engagement is involved, however the PLU must be subject to a local public enquiry before it can be adopted. Once adopted it has a legal and binding force.

The PLU will divide the commune into four zones:

- Zone U – New construction permitted which are likely to be existing development areas and those adjacent to it where the infrastructure exists or can be provided to enable development.
- Zone AU – Future development area, which will include either those where infrastructure is already available or where it is planned.
- Zone A – Agricultural area and only agricultural related new construction permitted.
- Zone N – Protected areas where no new construction permitted by virtue of their sensitive historical, ecological or environmental nature.

The plan will set out the general planning rules that will apply within each development zone.

In particular, it defines rules on change of use, permitted height of buildings, building arrangement, any architectural requirements, and public utility services and requirements.

As the preparation of a PLU is sometimes disproportionate to the needs of smaller rural communes, the government has granted these communes the option of preparing a more limited local plan called a carte communale. This identifies those areas in which development is, and is not, permitted. Unlike the PLU no specific planning rules are specified. Where development is not permitted, only extensions or changes to existing buildings can be granted: although there is exemption for agricultural buildings. The preparation of a plan avoids the need for 'in principle' deliberation about individual applications on a case by case basis, as the plan determines whether or not new development will be permitted. This review has not established how many communes or groups have completed up-to date plans.

The PLU should also identify major risk constraints. Local prefectures have been tasked with the preparation of Predictable Natural Risk Prevention Plans (PPRn) (See section above). These set out where development is not permitted; where development is permitted subject to conditions and where development is permitted subject to local regulations (Deboudt 2010). It has not been possible to establish from the literature how the PLU and PPRn processes are linked with ICZM. It is likely that not all coastal areas will have a PLU or a PPRn in place (Deboudt 2010).

In addition to the PLU, Territorial Cohesion Plans - Schemas de Coherence Territoriale (SCOT) may be produced. These documents are subject to a public inquiry before they can be approved. SCOTs are strategic planning documents used at the conurbation level drafted by groups of communes to align policies on housing, transport and commercial development and on maintaining a balance between urban and rural areas. A development strategy for the area has to be set out in a Spatial Planning and Sustainable Development Proposal before a SCOT can be completed. The PLU has to be compatible with the SCOT where it exists.

Development management

Planning applications have to be compatible with the PLU or Carte Communale. Where a PLU is in place, planning permission can be granted by the mairie (or inter-communal body) for compliant applications. Otherwise all planning applications need to be determined by the county planning and highways department, called the Direction Départementale d'Equipement (DDE) and in consultation with the mairie. Some smaller local councils are not able to offer a planning service and continue to rely on the DDE to determine applications. Planning applications will also need to be compliant with PPRn zoning on flooding and coastal erosion, where a PPRn has been produced.

Other theseus case study countries

BULGARIA

The review was able to access only limited information on the Bulgarian planning system which is still evolving. This section draws on the Compendium on the spatial Planning System in the Republic of Bulgaria drawn up by the National Centre for Regional Development (undated) which mainly reflects the situation under the Spatial Planning Act of 2001 and Bulgaria's Law of Spatial Planning July 2009.

Municipalities and towns have an obligation to prepare general development plans for their area or part of it. These cover the general spatial structure and general purpose of the area: areas of urban settlement, forests, areas of environmental, cultural and heritage protection; areas in need of restoration with the rules and specifications that apply there; the location of physical infrastructure; areas of public and state property and their planning status and design considerations for the area. Significantly the plans are also required to determine areas with probable occurrence of predictable natural hazards and the necessary preventing and protection measures. These must cover flooding and coastal erosion risks. Municipal authorities are required to draw up their plans with reference to specialised mapping and other information which may include information on flooding, landslide and erosion data.

General development plans are drawn up in consultation with national and regional authorities to ensure their agreement with higher level plans, and policies are subject to a public debate prior to their approval. Citizens have the right to comment on and make suggestions regarding the general plan. General development plans are long-term strategic documents created to cover a period of 15-20 years.

In addition, municipalities and towns may draw up detailed development plans covering all, or more commonly a part, of their area or a specific development. Detailed development plans have to take into account the general development plan and interested parties have to be notified of the plans. Once approved detailed plans are mandatory for all property owners and land use beneficiaries.

It has not been possible to determine how much progress has been made in drawing up general development plans to date and deadlines were not set in the Spatial Planning Act 2001. Detailed development plans have more commonly been drawn up for small parts of municipalities or towns rather than whole areas leading to fragmented solutions (National Centre for Regional Development, undated).

POLAND

This section has drawn on a paper by Lendzion and Lokucijewski prepared in 2000 which may well be out of date and inaccurate in some detail. It does not therefore reflect more recent spatial planning legislation e.g. Spatial Panning and Development Act 2003.

All municipal and rural self-governing communes are obliged to prepare and approve a local planning document – a comprehensive plan covering the whole area of the commune. These have to take into account national and regional goals and policies as well as planning and other laws. The comprehensive plan is a strategic document identifying the broad direction of development in the commune and the principles governing development; functional zoning and areas for housing and other development; proposals for infrastructure development; areas for conservation and agriculture; local planning policy, and boundaries of areas for regeneration, major development or other programmes.

Another form of plan, a local physical development plan is generally not obligatory but may be prepared for a part of the municipal or rural area, if this is deemed necessary. This local development plan is legally binding and it thus provides the basis for both development management and control and the allocation of land between different functions and uses. It contains detailed regulations on land use and infrastructure services; sets local standards and building regulations and divides the area covered by the plan into building plots. A development plan has to be consistent with the comprehensive plan.

Some criticisms of the planning system are that national to local level planning is not well co-ordinated; that procedures for public participation are formal and inconvenient with few opportunities for dispute resolution and that local planning is often fragmented and ill-coordinated (Lendzion and Lokucijewski undated).

SPAIN

Local planning at municipality level involves two forms of planning with various names according to the region involved. It can include both general and more detailed local development planning. The respective regional governments' legislation classifies all land into one of three categories: urban land, developable land and land unsuitable for development. This review has not been able to establish the basis on which this classification is made and whether FCERM issues play any part in the classification of land as unsuitable. Municipalities are given the responsibility of implementing this classification system within their own area through the development of the local development plan. The plan identifies infrastructure, open space, environmental systems such as coastal or hydrological systems. The latter of which may be relevant to FCERM. The very detailed content of local development plans e.g. on building heights, landscaping and open space requirements contributes to a planning system that gives considerable certainty to the public (Burns 2010).

FCERM PLANS, DATA, MAPPING AND MODELLING

If spatial planning is to address FCERM, good information on flooding and coastal erosion risks are essential as well as mechanisms whereby this information is made available to spatial planning authorities.

Following a preliminary assessment to be completed by 2011, the Floods Directive (EC 2007) has made it a requirement for all EU countries with areas assessed as having significant flood risks to provide flood hazard maps and flood risk maps. The maps must show the potential adverse consequences associated with different flood scenarios, including information on potential environmental pollution and an assessment of activities that have the effect of increasing flood risk. Maps are seen as necessary for information, for priority setting and for decision making. This includes spatial planning decisions, although spatial planning is not explicitly mentioned in the Directive.

The Directive also requires Member States to provide appropriate flood risk management plans by December 2015 with a view to avoiding and reducing the adverse impacts of floods. This requirement is based on the recognition that the causes and consequences of flood events vary across the countries and regions of the Community. Flood risk management plans should ensure relevant coordination within river basin districts, and promote the achievement of environmental objectives laid down in Community legislation. They should focus on prevention, protection and preparedness. With a view to giving rivers more space, they should also consider, where possible, the maintenance and/or restoration of floodplains, as well as measures to prevent and reduce damage to human health, the environment, cultural heritage and economic activity. The elements of flood risk management plans should be periodically reviewed and if necessary updated, taking into account the likely impacts of climate change on the occurrence of floods. Member States are asked to encourage active involvement of interested parties in the production, review and updating of the flood risk management plan and to make assessments, maps and plans available to the public.

Member states are required to show on maps the flood extent, depth or water level and where appropriate the velocity and relevant water flow for three scenarios.

- floods with a low probability, or extreme event scenarios;
- floods with a medium probability (likely return period ≥ 100 years);
- floods with a high probability, where appropriate.

Thus the Directive will ensure that comparable assessments of flood risk, maps and management plans are available by 2015 in all the Member States. Some of the Member States have already gone some way towards meeting the requirements of the Flood Directive with their pre-existing mapping. There is currently no EC Directive covering erosion risks that would standardise the provision of information on these risks.

In England, there has been a long tradition of providing flood maps to local planning authorities. However it only became possible to have a detailed and prescriptive policies on development and flood risk, when modelling techniques improved in the 1990s and it became possible to develop nationally consistent flood modelling and mapping to guide spatial planning. The EA provides flood risk maps to local planning authorities showing the extent of river, coastal and tidal areas with a given probability of flooding. These maps are updated when new information becomes available, usually on a three monthly basis. Local authorities in England are required to provide flood risk assessments and these do cover issues such as the depth of flooding, velocities and flow paths. Mapping of forms of flooding other than tidal, coastal and river flooding, such as urban flooding, is still under development in England.

ROLES OF THE PUBLIC AND PRIVATE SECTORS.

A key factor in spatial planning is the nature of the roles of the public and private sectors in planning and development. Countries vary in the extent to which development is plan led or market lead. England and Spain are thought to be unusual in the extent to which development is market led with a much lower level of direct public involvement in the implementation of new development. In these cases public planning is undertaken primarily to promote and regulate the actions of private developers (EC 1997).

In England land is allocated for development and for different land uses in the development plan. However whether or not development is realised as planned will often depend on a private developer coming forward with proposals, or on a partnership arrangement between the local authority, developers and other stakeholders. Furthermore, developers may bring proposals for development outside the areas allocated for development in the plan.

In many other EU countries, the relationship between public planning and implementation is much closer, with the public authorities having extensive powers to realise development (EC 1997). A proactive policy-driven land assembly and land supply processes in the Netherlands, Germany and France, contrasts with the more passive and reactive approach in England (Oxley et al. 2009).

THE MATURITY OR COMPLETENESS OF THE SPATIAL PLANNING SYSTEM.

In conclusion, it is useful to consider criteria for judging the maturity or completeness of spatial planning systems. A number of factors have been identified as indicative of maturity in spatial planning systems by the European Commission (EC 1997). These are important matters that need to be explored in the case studies.

Public acceptance and enforcement

The degree of public acceptance of the need for planning and regulation, and linked to that, the degree of compliance and the effectiveness of enforcement mechanisms are important considerations. In the absence of survey data on the public views, it is difficult to assess the degree of public acceptance except in terms of behaviour: i.e. do members of the public comply with spatial planning law and regulation; although compliance will also reflect the perceived efficiency of existing enforcement arrangements. In England, planning proposals and decisions are often controversial at local and national level but this is perhaps inevitable since planning is a process that seeks to find a balance between often conflicting interests. Planning procedures, and in particular planning application processes, are often criticised as bureaucratic, cumbersome and slow and there has in recent years been a constant search to make planning processes quicker and simpler (Killian Pretty Review 2008).

All the Theseus countries have procedures that enable enforcement action to be taken against unauthorised building works and land uses. However, the amount of unauthorised development that occurs varies between countries. Spain has been identified as having a particular problem in this respect (EC 1997). The liberalisation of the planning system in Spain also had an important role in the expansion of house building from 1996 to 2007 (Oxley et al. 2009). Some countries pursue enforcement more effectively than others. Most countries have the power to order complete or partial demolition or reversal of a change of use. In some countries e.g. Germany penalties may be imposed financial penalties as well (EC 1997). In England it is possible for planning permission to be granted retrospectively.

The provision of up to date policy instruments and plans.

Not all local authorities have development plans in place and some of the plans available are not up to date. According to the Compendium, there were some countries such as Germany, the Netherlands and Italy where a binding regulatory plan has to be in place before development could take place outside of an already built up area (EC 1997).

In England, the development plan process for producing Local Development Frameworks (LDF) was established in the Planning and Compensation Act of 2004, but there are still some local authorities that have not successfully adopted the key document (the core strategy) and many still have other LDF documents to produce. In England, there is evidence that managing development, when local plans and policies are out of date and do not reflect national policy, can cause difficulties (Tunstall et al. 2009).

In Germany, municipalities operating without up to date plans have in the past been reported as problematic for the spatial planning process, although this situation might have changed in recent times (Greiving and Turowski undated). In Bulgaria, it has also been reported that financial constraints hamper the production and updating of municipal Master Plans. Furthermore Bulgaria's Spatial Planning Act 2001 does not contain an explicit requirement and deadline for updating plans (National Centre for Regional Development, undated). It is possible that both these issues have been addressed in recent years in Bulgaria.

The degree of vertical integration and co-operation between level of administration

Most spatial planning systems are hierarchical with lower level plans required to be consistent with higher level plans. However systems may vary in how successful they are in achieving this vertical integration. In Germany there is a collaborative mechanism in spatial planning. The planning strategies from the lower level have to be taken into account when devising plans and principles at the higher level, especially in planning infrastructure. The lower level plans are obliged to reflect the guidelines and principles of the higher level (Oxley et al. 2009). In the case of Poland, Lendzion and Lokucijewski (undated) report that plans are made and controlled independently by the respective regional or local self governments. Although the intention is that lower level plans should be compliant with higher level plans, the criteria for compliance are not clearly defined and dependent upon the relationships between authorities (COMMIN undated).

The existence of transparent and productive mechanisms for consultation and engagement.

The Aarhus Convention on access to information, public participation in decision-making and access to justice (UNECE 1998) gives everyone the right to have access to information on environmental matters, to participate in environmental decision-making and to access justice. The provisions of the Convention have been embodied in two EC Directives, Directive 2003/4/EC on public access to information, and 2003/35/EC on public participation in Environmental decision-making. The Convention and Directives clearly apply to spatial planning in Europe.

The extent to which these objectives are realised in spatial planning the different EU countries is likely to vary in a number of ways:

- in the legal requirements;
- in the mechanisms used to inform and for consultation and engagement;
- in how wide and inclusive the processes are in terms of the stakeholders and members of the public reached;

- In the duration and timing: from one-off events to continuous involvement.

The following gives some indication of the legal requirements and differences in consultation processes in some Theseus countries. Public consultation and engagement is a field in which there has been significant development over recent years and the information for some countries presented here may not reflect current practice.

In England, planning law and guidance make clear provision for informing and consulting stakeholders and the public. The guidance (PPS 12) places strong emphasis on public consultation and engagement throughout the plan-making process. Local authorities are required to produce a 'Statement of Community Involvement' outlining their strategy for engaging the public in the preparation of each of their DPDs and also to report on how they have carried out their strategy.

Planning documents, applications and decisions are available to the public on the internet and in printed form. While formal processes of consultation on documents and via public meetings and exhibitions are used, more deliberative and participatory methods such as workshops and visioning exercises are also employed in developing plans. There is substantial stakeholder and community involvement in the development of the non-statutory Sustainable Community Strategies which feed into local development plans in local authority areas.

Information provision and consultation methods associated with spatial planning in Poland have been criticised as formal and limited although some innovative planners have organised discussion events (Lendzion and Lokucijewski , undated).

In Bulgaria, draft regional development schemes are subject to public debate prior to their submission to an Expert Panel. The authorities developing the plan decide on the stakeholders to involve, the procedures and the organisation of the debate. A similar process is undertaken for Master Plans for Municipalities and towns. Every citizen has the right to participate in the public debate and to express his or her views on the proposals. Detailed plans are not subject to this process but interested parties within a given area have to be notified and there are requirements for official and press announcements of the detailed plans (National Centre for Regional Development, undated).

In Germany, as required by the Federal Building Code, local planning is reported to involve intensive public participation in two phases. The first phase covers early involvement of the public, public agencies and neighbouring municipalities. The second formal phase occurs when a draft plan is put on display and any member of the public is entitled to inspect the plan and make suggestions. The municipality is obliged to examine carefully any suggestions made because the treatment of public responses is regulated in detail by the Federal Building Code (Greiving and Turowski undated).

Impact on Urbanisation and Spatial Planning: Survey Guide for ground testing

Aims

This survey guide is designed to collect data via interviews to help meet the aims of WT4.2. These aims are to:

1) To investigate the role that innovative methods of using spatial planning and controlled urbanization could play in restricting the impact that hazards bring at the coast

2) To examine the potential for innovative governance arrangements to facilitate the innovative methods of using spatial planning and controlled urbanisation

These goals will allow for the ground testing of land use planning based mitigation options.

The primary research question focuses on how can we build more flexibility into decision-making processes to facilitate an increased capacity for strategic and spatial planning to adapt to both planned and surprise change. The proposal focuses in detail on the planning systems, gathering basic pertinent information on methods of appraisal and governance processes as these relate to the delivery of spatial planning.

Conceptual frameworks and methodology: interfacing ideas of spatial planning with the concepts underpinning the work package portfolio.

A number of conceptual frameworks have been reviewed prior to the development of this survey guide, each different in character and extent. The frameworks have been proposed to provide, to varying degrees, conceptual framing for the range of tools being explored across the work package. We have therefore attempted to drawn on each framework in the development of the survey guide questions. This section briefly overviews the applicability of these frameworks to WT4.2. Appendix 1 outlines the initial issues and question prompts that had emerged from the analysis of the conceptual frameworks.

The first of these frameworks is the Wardekker et al (2009) conceptual model for operationalising the resilience approach. The framework is useful in terms of the operational perspective that it brings, although not all of characterisations of resilience can be translated to concepts and processes within the spatial planning. However, whilst useful at the operational level, we have found this framework restrictive in terms of exploring processes of innovative spatial planning. We envisage the Wardekker et al. model to be useful in terms of analysing details of existing spatial plans and policies for cataloguing 'resilience promoting' components of spatial planning practice. As a guide for exploratory questions, it is much less effective.

To help facilitate thinking towards innovative approaches, we have reviewed a further set of ideas emerging from the resilience alliance including the concept of transformation within resilience thinking. An interesting discussion has emerged during the last few years within the resilience community which focuses on the limits of resilience and the fact that resilience is not always a good thing: sometimes change is desirable. We feel that there is added research value in exploring resilience principles in the context of this proposition. It brings the important perspective that resilience processes are not only those which maintain the desired configuration of the system but include processes which build the capacity for transformation of the system should it be needed. This is translated within the survey guide into questions focusing on envisioning and scenario analysis.

Two other conceptual frameworks have been discussed at the Work Package level. The first looks at the source-pathway-receptor 'model' of flood impacts. This was of limited aid to the development of the survey guide. The framework serves to show that whilst spatial planning can have some impact on the pathways through which flood risk is transferred (some effect in creating "green areas" through which flood waters could flow, and possibly creating barriers to flood flow); we are fundamentally concerned with the receptors of flood impacts (the major effect of urbanisation and spatial planning on the exposure of assets at risk and their vulnerability). The second framework is derived from Ortwin Renn's work on risk governance and explores the influence which spatial planning might have on the level of risk exposure. Spatial planning is value-driven, that is it is concerned with identifying, understanding and mediating conflicting sets of values within a particular space; hence spatial planning might deal with the issues of relevance claims. In addition, spatial planning also deals with normative claims, particularly if spatial planners use visioning tools as a process for obtaining local consensus on how local communities should, and could, develop over the foreseeable future. The reinforces the importance of questions within the survey guide which focus on scenario analysis and envisioning, as well as those which seek to explore public engagement in spatial planning.

The following suggested structure of the interview, as well as the proposed interview questions, are derived from the proceeding literature review of spatial planning and the various conceptual frameworks as identified above.

Methods

Sampling

The details of the sampling in this research are to be determined locally by THESEUS researchers active in the relevant study site, in consultation with FHRC. Discussions with Work Package colleagues at the May 2011 Gdansk meeting concluded that we should seek interviews with:

- Key informants to arrange initial interviews with: planners from both local and strategic levels (the latter depending on the case-study area)
- Environment Agency (or equivalent strategic regulator with responsibility for flood and coastal erosion risk management)
- Key developers
- Local councilors

- Community groups and possibly land owner representatives

Given the complexity of spatial planning arrangements, snowballing should be used as a technique for identifying the range of interviewees which should be included in this survey. Using this technique, a few key respondents will be identified for initial interview. During the interview the participant should be asked to suggest the names of additional people or groups with a stake in the key issue whom they felt should also be interviewed.

As a guide, we envisage the total sample size being 10-12 interviews for each study area.

Secondary sources of data

The literature review presented in this deliverable has sought to review spatial planning policies and practices in the range of study sites relevant to this work task and has used as many secondary sources of data as possible. However, by necessity the literature review has been weighted towards those planning systems for which we've had relative easy access to published information.

We are strongly dependent on our work package colleagues to reflect on the literature review for each of their respective home countries and to provide feedback to us on any errors or holes in the data. We hope to build on comments and suggestions for revisions as provided by work package colleagues for each of the study sites and supplement the findings in this report. This information will be provided within the final draft.

Work package colleagues should reflect, in particular, on the following information:

i. Current spatial planning policies and regulations

ii. Current spatial planning governance arrangements

iii. Powers of spatial planning: what they can do

iv. Information on private property rights – what they can't do

v. Outcomes of spatial planning and how these relate to flood risk management: who gains and who looses

vi. Primary geographic scales of activity e.g. local, regional planning

In-depth, semi-structured interviews.

The approach to be used is in-depth, semi-structured interviews. The aims are exploratory, rather than definitive. We want more information on ideas and tendencies than on facts and figures.

As discussed above, it is likely that the analysis of the interview results will be structured around themes as emergent from the preceding literature review and from the specification of the work task objectives from within the Theseus Document of Work (see box below).

However, when conducting the interview we recommend that a simpler grouping of topics is followed: that is, simpler in terms of guiding the interviewees in a recognisable path through the range of interview questions. We are proposing that the interviews are organised around following broad structure:

1) Exploring the international, national and regional context of the role of spatial planning in managing flood and coastal erosion risk

2) Understanding spatial planning and opportunities for innovation at the local scale

a. Local development plans

b. Property rights and planning permissions

c. Public consultation and engagement

3) Flood and coastal erosion information and maps

4) Maturity and evaluation of the planning system

Potential key analytical themes for the interview data

Key question: how can spatial planning contribute to building more resilient coastal futures?

Theme 1: Do planning systems recognise and know about the problems of coastal flooding and erosion?

The analysis will focus particularly on interactions and inter-relations between spatial planning and flood and coastal erosion risk management across different management scales (FCERM).

Theme 2: What are the processes and attributes of spatial planning which facilitate resilience building to coastal flooding and erosion, as well as increase opportunities for transformation of coastal regions?

Guide tot he types of questions which may be asked for each theme.

It will be important to give a brief introduction to the project and to the interview; this could include some of the following information.

This interview is conducted within the auspices of the EU-funded THESEUS project which is examining the application of innovative coastal mitigation and adaptation, aimed at delivering a low-risk coast for human use/development and healthy coastal habitats as sea levels rise and climate changes.

The focus of this interview is on investigating the part that spatial planning, and particularly the part that innovative ways of using spatial planning, could play in managing flooding and erosion risks at the coast. We are also interested in examining the potential for new and different governance arrangements to facilitate innovative methods in spatial planning.

In order to do this, we are carrying out interviews with spatial planners, developers, managing of coastal risks and other key informants in coastal case study areas in five different European countries to see what methods and innovations have been used or could be developed in those settings.

We have attempted to make questions (or at least sub-components of questions) suitable for a range of informants (e.g. spatial planning, developers, flood risk managers). Some alterations to the questions might still be necessary depending on the category of interviewee and the scale at which they operate within their respective role. As a guide, we have added the symbol at the end of questions which we think might be more strictly directed towards spatial planners. However, the interviewer should feel to use these questions as and when he/she feels appropriate. Finally, some of the questions might not be appropriate for all study sites: a few questions have been added because we at FHRC did not know or could not access the answer. However, if any of these basic information gathering questions can be answered by WP4 colleagues, then they need not be included in the interviews.

We'd like to open with interviews with a broad question before going into the detail of the analysis:

1. Lots of people have different views on what spatial planning is for and what it is about, before we get into the detail, could you give me your broad view on what spatial planning is all about?

THE INTERNATIONAL, NATIONAL AND REGIONAL CONTEXT:

2. In your experience (as a spatial planner, developer, risk manager, other key informant) to what extent is spatial planning in the case study area influenced or constrained by international treaties or EU policies e.g. EU spatial development policy, RAMSAR sites, EU Directives: e.g. Birds Directive (SPAs) Habitats Directive (SACs), Marine Strategy Framework Directive?

3. At the national or regional level, are there spatial planning policies, plans or guidance that address the issues of coastal flooding and erosion risk management? E.g.in England PPS 25 and supplement and that affect spatial planning at the local level?

4. How is flooding and coastal erosion risk management (FCERM) linked into the planning system at national and regional level? In your opinion is this linkage successful? Why?

5. Which ministries and other bodies are responsible for spatial planning and FCERM?

I understand that the main bodies responsible for FCERM and spatial planning in this country are xx and xx . Is that right? How are national policies co-ordinated?

In your view do these arrangements foster integration of policies between FCERM and spatial planning at national level? (this Q may not be suitable for local level informants)

6. How, if at all, is ICZM linked into spatial planning at national and regional level?

7. In your opinion, does a federalised or regionalised structure allow spatial planning to be better tailored to regional and local needs?

Do these arrangements foster innovation in spatial planning given that different approaches are tested in different regions? Are you aware of different approaches in other regions/lande/states?

Do these arrangements foster integration of FCERM in spatial planning (this Q also may not be suitable for local level informants)

8. In your view, where does the locus of power lie in spatial planning in this country: at national regional or local level: where are most important decisions on spatial planning made? How much flexibility and scope is there for decision making in spatial planning at the local level?

SPATIAL PLANNING IN THE REGION/LOCAL CASE STUDY AREA

LOCAL DEVELOPMENT PLANS

9. What local development plans are the local spatial planning authorities required to make? What plans are available for this area? How up to date are the plans?

10. Do they contain any policies that related to FCERM? If Yes, what do the policies involve?

11. Are there zoning arrangements in the local area? If so, what are the zoning criteria and are considerations of FCERM included in the zoning criteria?

12. How detailed, and specific or flexible and general are the policies and zoning criteria?

13. Combined question for non-spatial planners:

There are a number of spatial planning policies and zoning arrangements that are related to FCERM in this study area, what are your views on these?

If there are no policies related to FCERM: My interviews with spatial planners have highlighted that there are no spatial planning polices related to FCERM, do you think there ought to be?

14. To what extent is the local spatial planning system plan lead? i.e. do site specific planning decisions have to be in conformity with the local development plan, its policies and zoning and with higher level plans (as they affect FCRRM?) If so how rigorously or flexibly is conformity to plans enforced? How is conformity enforced?

15. Are there examples in this case-study area of innovative informal planning processes i.e. planning processes not required by law and not strictly within administrative boundaries but covering for example special geographic areas e.g. sub-regional plans or groups or part of local authority areas for special purposes (e.g. in UK Thames Gateway subregion)?. For what purposes have these been set up

and how successful have they been? Have any of them involved FCERM issues? How are these linked to formal/statutory approaches?

PROPERTY RIGHTS AND PLANNING APPLICATIONS

16. Are there any land and/or property owner rights that are written into the constitution or legislation? If so how do these affect spatial planning and planning at the coast?

17. How are land and property owners rights constrained/limited by laws, by zoning, by regulations?

18. Are there any categories of property, land or land uses that are exempted from planning laws and regulations? If so does this have any effect on spatial planning at the coast? In what way?

19. What are the main categories of property, land and land use that require planning permission or permits?

20. Can you describe briefly what are the procedures for obtaining planning permission/permits in this area generally and at the coast?

21. Can you think of examples in this area at the coast where the planning permission/permit process worked well and achieved the 'best'/right outcome?

22. Can you think of examples in this area (at the coast) where the process failed to achieve the 'best' outcome?

23. In your opinion, what are the main problems with the planning permission/permit process?

24. How could the planning permission/ permit process and planning decisions generally, and at the coast, be improved?

PUBLIC CONSULTATION AND ENGAGEMENT IN LOCAL SPATIAL PLANNING

(MIGHT ALSO INCLUDE SOME REFLECTION ON ENGAGEMENT AT THE REGIONAL SCALE)

25. What if any are the legal requirements to inform, consult and engage with stakeholders and the public in spatial plan making (at regional? and local level? EU Directive? and Aarhus Convention, national legislation?

26. What methods of information provision, consultation and engagement are used and at what stage in relation to the regional/local development plan process?

27. Have any of the following special techniques for engaging with stakeholders and the public been used in this area for spatial planning purposes e.g. scenario analysis, deliberative workshops, citizen/stakeholder panels or anything else? If so, in your opinion, how successful have such methods been? Are there any barriers/problems associated with their use in spatial planning?

The following question side-steps the issue of local communities, seeking to explore internal use of scenarios within planning communities. We have included the question in this section as it can be ‘tagged on’ to the discussion of scenarios in the previous question.

Does scenario analysis have a role internally, i.e. in discussion between spatial planners, in the process of producing local/regional development plans i.e. exploring possible different futures to help make strategic decisions in the present?

a. If yes, what types of alterative scenarios have typically been considered? In your opinion are there other futures, which could or should be considered and have not been?

b. If no, are there particular constraints which prevent the use of scenario analysis? In your opinion could it have a useful role? What themes or broad scenarios should be considered?

28. Are there examples from within your study area where it has been difficult to get people to accept change at the coast? If yes, what do you think are barriers preventing people from accepting or envisioning change? Does flood memory play a role in this?

29. Experience of spatial planners has show that through deliberation on strategic or local plans conflicts may be eased but disagreements can often resurface at the implementation stage when specific development proposals are made.

Are there any examples of this in this area and how have the conflicts been resolved?

30. What are the usual or required arrangements for informing and consulting with stakeholders and the public about applications for planning permission/permits? How well do these arrangements work? How could these information and consultation processes be improved?

31. It is often assumed that spatial planning if undertaken in an open, transparent and collaborative way will lead to consensus and better development. Are there any examples in your area where this has happened or examples of where it has failed to achieve this?

32. Are there networks or organisations representing different groups in the local area e.g. interest groups, community groups, business and other groups that spatial planners meet up with to discuss issues of FCERM? How do they interact? On a regular basis or just intermittently? In your opinion how useful are these meetings?

33. Are there any professional groups or networks with a focus on FCERM that spatial planners interact with? How do they do so? On a regular basis or intermittently?

34. In what ways do you think that information provision, consultation and engagement with stakeholders and the public could be improved in spatial planning in your area? Generally and in relation to FCERM?

FLOOD AND COASTAL EROSION INFORMATION AND MAPS AS IMPORTANT INFORMATION FOR SUPPORTING SPATIAL PLANNING

35. What information and maps on flooding and coastal erosion are available to you (NB Floods Directive requires maps to be produced) and how do you access this information?

36. How are flooding and coastal erosion defined for information and mapping purposes?

37. Do definitions of FCERM take vulnerability (e.g. different land use types) into account as well as probabilities (as is the case in England in PPS25)?

38. In your view, how much uncertainty attaches to the information available on flooding and coastal erosion? Is this a problem for spatial planning? Are there mechanisms to deal with this (e.g. short-term planning permissions, limited life and set-back)?

39. Are spatial planning strategies as yet being prepared and implemented in this area in accordance with the Floods Directive to appraise, manage and reduce the risks of flooding coastal erosion?. How are the strategies being developed?

If no, what progress if any has been made towards preparing and implementing.....

40. Is there a monitoring framework for local planning authorities to assess progress in appraising, managing and reducing flood (and coastal erosion risk)? If not how is performance assessed? Floods Directive does not cover coastal erosion.

41. What other strategies and plans are there for this area that address flood and coastal erosion risk management at the coast e.g. ICZM, flood management strategies, e.g. in England Estuary Management Plans, SMPs? How are they linked into spatial planning?

THE MATURITY OF THE PLANNING SYSTEM AND AS WELL AS MECHANISMS FOR EVALUATION OF SPATIAL PLANNING SYSTEM

42. To what extent is there public acceptance of the need for spatial planning and the regulation of the use of land? What evidence is there for this in the case study area?

43. What mechanisms are in place to ensure that site specific planning applications are in accordance with the development plan, its policies and zoning arrangements? How effective are these mechanisms?

44. To what extent is non-compliance with spatial planning plans and policies a problem in this area, generally and in relation to the coast e.g. is there much illegal buildings, extensions, change of use, generally and at the coast here.

45. What would you say are the main problems in local spatial planning in general and in relation to FCERM

46. In your view, does the spatial planning system encourage or allow innovative approaches to planning in general and to planning in relation to FCERM?

47. How could the (local) spatial planning system be improved?

48. Are there any other issues or factors that you see as relevant that we haven't touched upon?

BUSINESS DISRUPTION AND RECOVERING: BUSINESS CONTINUITY PLANNING AS A MITIGATION OPTION[4]

OBJECTIVES

The objective of this sectiob is to evaluate the implications of current knowledge on Business Disruption and Recovery (BDR) in relation to the THESEUS DOW, partly in order to inform the developing survey guide for WT4.3 fieldwork for groundtesting.

From the DOW the aim of the WT4.3 is to "investigate the role that innovative methods of managing business operations could play in reducing the impact that hazards such as flooding bring at the cost and in estuaries. The aim is to investigate how far these methods might minimise the need for (or the design standards of) the kinds of major coastal and estuarine defence structures that otherwise would be needed in the future with climate-change induced sea level rise".

BUSINESS DISRUPTION AND RECOVERY PLANNING – EVOLUTION AND INNOVATION.

Terminology is important here. The abbreviation 'BDR' is usually referred to as Business Continuity Planning (BCP). But Business Continuity Management (BCM) or Business Continuity and Resilience Planning (BCRP) are also terms sometimes used. The abbreviation BCP is not especially new and comprises a well-developed cluster of standards and processes. However, evidence (see below) indicates that the application of BCP throughout Europe is likely to be uneven. This is because BCP standards and planning have evolved over several decades, influenced by developments in emergency planning, hazard management and banking and finance. Business regulatory and audit requirements, customer protection requirements, shareholder interests and local economic/employment community security issues have all also been major factors pushing businesses to take-up BCP.

The modern origins of BCP may be traced to Y2K preparations and the 9/11 (2001) terrorist attack which gave a major stimulus to develop a 'resilience movement' aimed at increasing capacities (institutional, governmental, societal, economic, business, individual) to absorb and adapt to hazardous events of all kinds. During the 2000-10 decade climate change concerns, the growing number of natural and na-tech disasters and a politically and economically less stable world, all added considerable impetus to BCP. Many businesses in Europe experienced some degree of disruption when the Icelandic volcanic ash spread across Europe disrupting business travel and freight movements and all businesses can be expected to have fire detection, alert and response plans in place if they have nothing else. In the light of the 2011 Japanese earthquake and tsunami, and following the Icelandic Ash Cloud events, businesses are now beginning to learn that a stable world can no longer be assumed and that planning for an unstable world is beginning to be very important.

[4] Contributors: Dennis Parker, Edmund Penning-Rowsell and Loraine McFadden, Middlesex University

The number of institutions (e.g. British Continuity Institute, an acknowledged leader in BCM and it's certification) promoting BCP has grown rapidly; BCP is now a key part of Business School curricula and a range of detailed BCP standards are enshrined in ISO standards (e.g. ISO 17799 and ISO/IEC 27001 on information security) which have UK national counterparts (e.g. BS 25999 on Supply Chains and BS7799 on Information Security). Generally, however, although take-up of BCP has been growing it remains lower than is ideally desirable and sometimes untested by real-world events.

BC (i.e. Business Continuity) and DR (i.e. Disaster Recovery) planning has become routine in medium to large businesses: the take-up challenge lies in small businesses where take-up is lower. Innovation appears to come mainly in (a) the form of business impact analysis (here there are branded processes and software) where there is scope for innovative modelling including scenario analyses, (b) within the particular BCP strategies developed by individual businesses faced with particular circumstances and where creativity comes into play, (c) in testing and evaluating the effectiveness of BC plans (including the application of lessons learned from real disruptive events); and (d) in ways of interfacing or integrating firms' BC strategies with those of related companies (e.g. supply chain companies).

The BCP concept

BCP is the umbrella term used for a set of methods and techniques (Figure 10 below). Like many others in this field, Snedaker (2007) includes disaster recovery (DR) planning in BCP and conceptualises BCP as comprising a number of steps: (i) risk analysis, (ii) business impact analysis, (iii) mitigation strategy development, (iv) business continuity plan development, (v) training and testing and (vi) business continuity of disaster recovery plan maintenance.

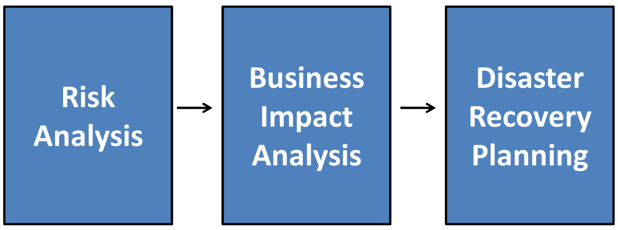

Figure 10: The main components of BCP

Overview of the current generic knowledge and literature base.

A number of sub-disciplines contribute to BCP knowledge including business analysis, business management, IT management, impact analysis, forensic accounting, litigation economics, forensic economics, crisis management, disaster management and insurance. Litigation economics is a particularly large field in the USA and is associated with the allegations that business corporations frequently make about their economic losses being caused by other business entities. There are a number of journals which both represent and reflect these fields including the Journals of: Contingencies and Crisis Management; Business Continuity and Emergency Planning; Forensic Economics; Legal Economics; and the Disaster Recovery Journal. Not surprisingly there is now a substantial BCP literature which may be categorised in a variety of ways including that adopted for this study in the bullets below. Because of the size of the North American business sector, much of the literature originates in the USA. Also the vast majority of BCP knowledge is derived from business disruption other than from flooding (which is the 6th most common cause) and other coastal risks, although the most significant stimulus to BC and DR planning is natural disasters and extreme weather events closely followed by power outages (some of which may be caused by extreme natural events) (Figure 11 below). However, importantly, most of the existing knowledge is generic and is likely therefore to be generally applicable to flooding and other coastal risks in Europe.

An implication is that in designing fieldwork, full consideration should be given, at least initially, to examining BCP in relation to all disruptive events and not just flooding and coastal risks. It is likely that businesses will have encountered business disruption (events or risks) from severe weather, power cuts, IT failure, volcanic ash clouds and possibly threats to work force availability owing to pandemics (e.g. influenza) etc. and that it will be possible to learn about BCP strategies applicable to flooding and coastal risk through the lens of these experiences.

A typology of BCP or BDR literature and knowledge is presented herbelow:

- Business impact analysis (BIA) for business continuity and recovery
    - BIA process
- Business interruption losses
    - Litigation/forensic economics
    - Flood loss estimation
- Studies of business damages and consequential losses and recovery
    - Supply chain risk simulations

- Input-output models
- Post event industry surveys
- Insurance studies

- Statistical surveys of BCP and DR planning take-Up
- Conceptual studies
    - Flooding disruption
    - Resilience

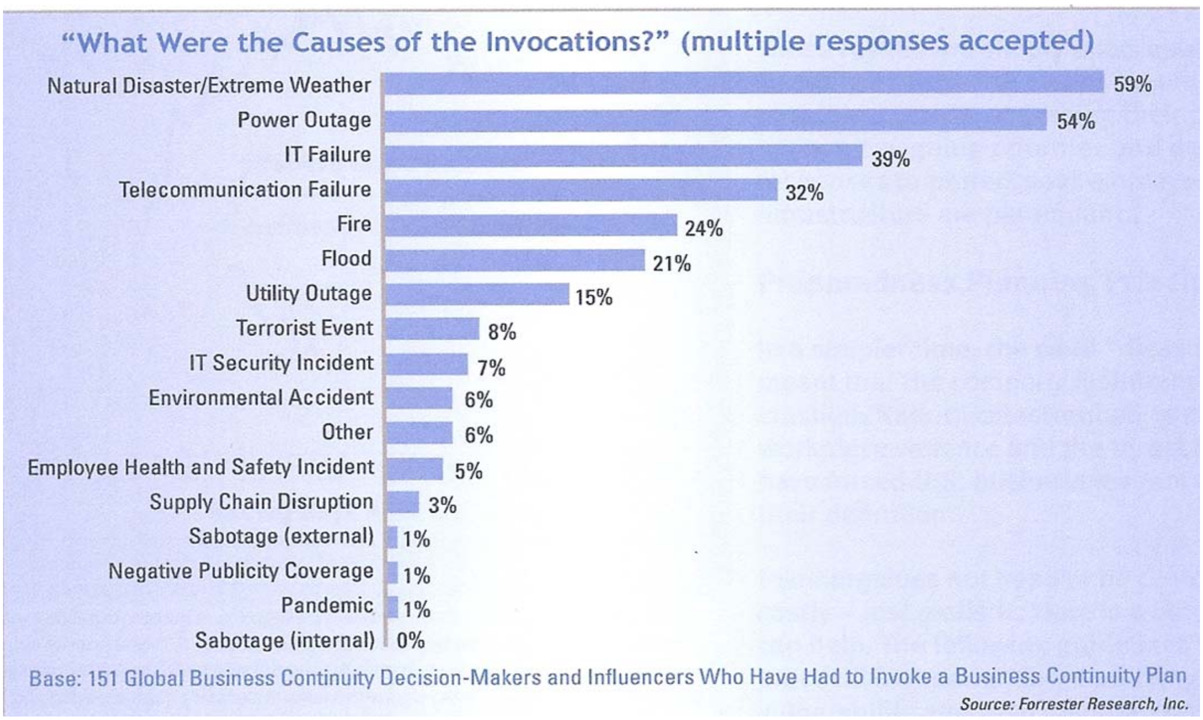

Figure 11: Causes of the introduction of BDR planning (Source: Chase (2009)

How to go about BC/DR planning

There is now a vast array of volumes and websites which are more or less step-by-step guides on how to go about BC/DR planning. These either focus on BCP and BCM or closely related subjects including 'incident response', 'emergency planning' or 'disaster recovery' for businesses and often provide tips and/or 'reveal' secrets (e.g. Snedaker, 2007; Barnes, 2001; Hiles, 2011, Wallace and Webber, 2010; Osborne, 2007; Syed and Syed, 2003, Shultz and Shumway, 2002; Fulmer, 2005; Erickson 2006). These volumes explain the BCP process in great detail and explain how to go about BC/DR planning. They often include guidance on risk analyses focusing upon threats such as electricity failures, natural disasters, manufactured risks, supplier risks, pandemics, viruses and hacking. Among other things they emphasise the importance of protecting and making accessible during a disruptive or damaging event items such as vendor and supplier lists, asset inventories, software asset lists, and identities and contact details of trained first responders. They also set out how to undertake BIAs and how to create recovery plans and how to maintain contact with virtual workers using VPNs. They explain uninterruptable power supplies, surge protection, the need to indentify critical telephone circuits and to have a telecommunications mitigation plan. Some texts focus specifically on advice for small businesses (e.g. Childs, 2008). There are also texts which focus on crisis management in particular industrial sectors such as the food and drinks industry (Doeg, 2005) or the tourism industry (Glaesser, 2006). There are ebooks (e.g. http://ebookee.org/The-Project-Surgeon-A-Troubleshooter-s-Guide-to-Business-Crisis-Management_974596.html) and websites providing DIY advice on one or more aspects of BDR planning include:

http://www.thebci.org/

http://www.londonprepared.gov.uk/businesscontinuity/

http://www.direct.gov.uk/en/HomeAndCommunity/InYourHome/Dealingwithemergencies/Preparingforemergencies/DG_175927

http://www.continuitycentral.com/feature0501.htm

http://sbinformation.about.com/od/disastermanagement/Disaster_Recovery_Planning_and_Management_for_Small_Business.htm

http://www.businesscontinuityadvice.com/

Business Impact Analysis

Most of the texts cited in the section above include chapters on the BIA process. One of the most comprehensive of these is Snedaker (2007) who explains that there are four primary purposes of BIA:

- to understand an organisation's most critical objectives, the priority accorded to each and the timeframe for resumption after unscheduled interruptions of business;
- to inform management decisions about the Maximum Tolerable Outage (MTO) for each function;
- to provide resource information on a range of appropriate recovery strategies; and
- to outline dependencies that exist both internally and externally to achieve critical objectives of the business.

Identifying criticality in business functions is a key to BIA and Snedaker distinguishes between 'mission critical', 'vital', 'important' and 'minor' functions.

BC/DR modelling and performance evaluation is part of BIA and focuses on a detailed finding fault approach to business recovery systems and the consequences of these faults prior to taking remedial action (Cesura, 2005). Various 'timestamp concepts' are used for each of a number of key events in business disruption and recovery scenarios, and an example from Cesura is as follows:

- TTA: Time to Alert: The precise interval of time between the injections of a fault in the business environment until the test subject knows there is a business disruption (poor end-user experience that is impacting the business).
- TTI: Time to Identify: The precise interval of time between the test subject's awareness of a
- business disruption and the time when the test subject knows the probable cause of the business disruption.
- TTC: Time to Correct: The precise interval of time from knowing the probable cause of the business disruption to correcting it.
- TTV: Time to Validate: The precise interval of time between problem correction and definitive validation that the corrective actions have eliminated the business disruption and users are able to perform the intended function.

Some businesses cannot tolerate downtime. Businesses in the banking, financial services (e.g. credit card companies), power, telecommunication and health sectors are often responsible for critical data processes and systems. In some such cases, this criticality and minimum standards of service may be dictated by law so that continuity of compliance during a disaster is very important. For each critical (in scope) function, the following concepts and values are assigned:

- Recovery Point Objective (RPO) – the acceptable latency of data that will be recovered (latency is the amount of time a message takes to traverse a system); and
- Recovery Time Objective (RTO) – the acceptable amount of time to restore the function.

The Recovery Point Objective must ensure that the Maximum Tolerable Data Loss for each activity is not exceeded. The Recovery Time Objective must ensure that the Maximum Tolerable Period of Disruption (MTPD) for each activity is not exceeded.

THESEUS WT4.3 fieldwork implications of these BC/DR modelling and performance evaluation conceptualisations are not easy to tease out. However, some businesses (probably the larger ones) may well be using such processes particularly if they are responsible for critical processes where speed of recovery is absolutely critical to protecting both shareholders, customers and company legal liability.

Measurement of business interruption losses

Gaughan (2009) provides a comprehensive discussion of a range of methods used by forensic accounting and forensic economics experts working for lawyers for measuring business interruption losses and related commercial damages. This field is concerned with (a) proving business interruption losses (Cerillo, 1991) and (b) determining or estimating them for litigation purposes (Gerald, 1995). Gaughan presents a methodological framework for measuring lost profits owing to business interruption and, for example, examines techniques of distinguishing between business interruption losses arising from disasters and background changes in revenues arising from economic recession, regional economic processes and international economic trends (Bonanomi et. al., 1998). He makes the point that in the worst cases business interruption can lead to bankruptcy and/or companies not continuing to exist.

Another field in which business interruption losses are sometimes estimated is flood loss estimation and flood alleviation benefit assessment (Penning-Rowsell et al., 2005; Meyer and Messner, 2005; Messner et. al., 2006). Parker et al. (1987) created a formulaic method for estimating the indirect business losses arising from floods and developed a business interruption loss data set for the UK based on over 100 interviews with businesses either affected by flooding or located in flood risk areas.

Studies of business damage and consequential losses and recovery

Business interruption studies may be categorised into four groups: a) supply-chain risk simulations, b) input-output models c) post-event business surveys, and d) insurance studies (Jain and Guin, 2009). The vulnerability of businesses to the disruption of the supply chain network has been demonstrated in many events. For example, the Taiwan earthquake in September of 1999 had an enormously adverse impact on the semiconductor industry. Hurricane Katrina and Hurricane Rita caused huge disruptions in the energy market when they damaged off-shore platforms and petrochemical processing plants on the Gulf Coast. The impact of hurricane Katrina on the Gulf Coast’s petroleum refining industry is examined by Kirgiz et al. (2009). The industry was forced to suspend operations for extended periods of time incurring substantial business interruption losses eventually triggering consequential loss insurance claims. Kirgiz et al. (2009) present a methodology for calculating refinery business interruption losses which takes into account the effects of the disaster on petroleum product prices.

Supply chain risk simulations model the uncertainty and interdependencies between different businesses in the supply chain network. These models assess the vulnerability of the supply chain and associated businesses (Deleris et al., 2004). The focus of supply-chain simulations is the assessment of the performance of a single business or group of businesses, whereas input-output models are used to model the impact of different events on the regional economy in terms of output of different industries, regional income, and employment (Rose and Lim, 2004). The Disaster Research Center in Delaware has undertaken numerous studies on the short and long-term impact of catastrophes on businesses. These studies have identified key variables that influence business disruption and recovery after disasters (Webb et al., 2002). Based on the data from the Loma Prieta and Northridge earthquakes the different factors contributing to downtime are divided into 'rational' and 'irrational' factors. The study discovered that irrational factors can be responsible for significant part of the downtime (Jain and Guin, 2009).

Business interruption studies in the insurance field examine the challenges in estimating business interruption exposure and losses from claims after an event. Using past financial data, a study by Foster and Trout (1990) describes different forecasting methods used to project business interruption losses for a business. Other studies (e.g. Swiss Re, 2004) describe the evolution of business interruption insurance in the industry. The complexity of business interruption coverage and business interruption claims has been regularly discussed in the insurance literature. Studies by insurance industry suggest a low awareness of business interruption coverage and high optimism among business owners for a speedy recovery after business disruption (Jain and Guin, 2009).

Besides other data inputs, both supply-chain simulation and the input-output model approach require the downtime functions for different businesses to estimate the business interruption losses from an event. Business downtime functions relate the hazard intensity or the property damage level (which is a function of hazard intensity) with the business interruption downtime for a type of business.

There are various case studies in which business interruption losses (sometimes called consequential losses) are evaluated. The Northridge earthquake of 1994 had a major disruptive impact on businesses in the Los Angeles area of California and became the focus of research into economic damages. Most of this research neglects business interruption damages or focuses on the overall extent of economic damage. Exceptions which focus on business interruption losses include the research of Boarnet (1996). Boarnet found that of 559 firms in his survey, 35% reported that they had suffered business losses owing to transportation damage while 10% reported business gains as a consequence of the earthquake. The 'redistributive' effect of disasters on businesses (i.e. losses and gains) is a common feature of most disasters. Using methods described above, Parker et al. (1987) estimated such flood loss potential in case studies of manufacturing firms in Barnstaple and in the River Trent catchment in England, and also in the city of Lincoln.

Brisbane's inundated businesses are estimated to have lost an average of more than $800,000 as a result of the 2011 floods. A Queensland Chamber of Commerce and Industry survey of almost 200 businesses revealed an average loss of $834,992 for businesses that had to stop trading as a direct result of flood damage or power loss. However, the median average loss was closer to $60,000, with the mean average swayed by losses incurred by heavy engineering and industrial firms (http://www.brisbanetimes.com.au/business/flood-losses-batter-brisbane-businesses-20110203-1aff9.html#ixzz1K2Xtlm3a).

STATISTICAL SURVEYS OF BD AND DR PLANNING TAKE UP.

Many websites report the results of surveys on BC and DR planning take up. A leader in the field - the Business Continuity Institute - reports a wide variety of statistics relating to BD and DR planning take-up (http://www.continuitycentral.com/news05623.html). For example, the following are reported in April 2011:

A new international survey of over 600 organizations by the Business Continuity Institute reveals that the vast majority of companies are failing to include business continuity considerations when making major strategic decisions.

- Acronis has launched its 'Global Disaster Recovery Index', a barometer which measures IT managers' confidence in their backup and recovery operations. The survey of over 3,000 small and medium-sized businesses conducted by the Ponemon Institute revealed that attitudes towards data backup and recovery differ widely around the world. Companies in Germany, The Netherlands and Switzerland they have the highest confidence that they can recover quickly in the event of system downtime: they are more than 50% more confident than the average. Businesses in the UK, Australia and the US all scored poorly on their confidence in their ability to avoid downtime in the event of a serious incident (27% / 44% / 38%). French and Italian businesses are the most likely to admit that they do not have an offsite backup and disaster recovery strategy (41% / 45%) and are the least likely to be able to recover quickly from downtime. They spend the lowest percentage of overall IT budget of all countries surveyed at 5% and 4% respectively.

- Janco Associates has just completed a review of 253 disaster recovery and business continuity plan activations and classified the shortcomings of those plans. The most common issue, occurring in 62% of all recovery plans were errors in the plans. This often was due to the plan not being kept up to date (47%), the unavailability or inaccurate passwords (34%), and failure of the initial restoration process (13%). Additional reasons for failures were: insufficient backup power – 22%; communications not in place – 18%; personnel not adequately trained - 17 percent; system recovery priorities not identified - 14 percent; recovery processes not sufficiently documented – 13%; and disruption event not identified quickly enough and activation was late – 12%.

- Star, a provider of on-demand computing and communication services to UK businesses, has released the results of a survey of 175 UK small and medium sized enterprises (SMEs). The results show that almost three-quarters (74%) of SMEs surveyed have some sort of formal business continuity plan in place: a surprisingly high figure. However, for organizations with fewer than 100 employees, the proportion with no business continuity plans in place rises to 43%, with respondents citing reasons as varied as budget, lack of in-house expertise and resources. The survey also reveals that more than a third of all respondents (40%) have experienced an incident which required them to invoke all or part of their business continuity procedures. This was due to unforeseen circumstances; from technical problems such as hardware or system failures, internet or network issues, or other factors such as severe weather conditions or a natural disaster.

CONCEPTUAL STUDIES

Parker (2007) conceptualises the flooding disruption of businesses directly and indirectly: the latter through linkages between suppliers and customers and through utility outages (Figure 12 below). Whereas flooding disruption has a negative impact, recovery activities may have an opposite, countervailing, effect on the economy, and because of linkages between businesses, flooding is likely to have both positive and negative economic multiplier effects which play out among businesses within a locality or region (Figure 13 below). For example, one businesses flood disruption costs may lead to other businesses' increase in business and profit. Importantly, Parker's conceptualisations introduce the scale issue which has implications for WT4.3. The scale issue is recognised as a fundamental concept when dealing with a location or territory (or a business within its business environment) and this has implications for BIA, business disruption and resilience. At least two scales must be considered: regional and local. The first permits the recognition of systemic links among businesses, business sectors and economies. Larger (i.e. lower resolution) scales may reveal vulnerability or resilience patterns and processes that are not recognizable locally and they may also reveal different forms of vulnerability or resilience as larger scales are not the simple sum of a number of "small scales".

WT4.3 fieldwork implications include firstly, the importance of understanding the business linkage environment in which businesses operate and their scale dimensions and secondly, the likely position of businesses located in coastal risk areas to both lose and gain from business disruption. A business which suffers flood or other coastal risk disruption which is able to apply BDR and effect a speedy recovery could also be one which benefits from the additional business opportunities generated by the hazard.

Wardekker et al.'s (2009) 'options for resilience' (i.e. homeostatis, omnivory, high flux, flatness, buffering, redundancy, other) are different pathways to resilience which may be applied to BDR thinking and suggest a number of lines of questioning (as already identified by E. Penning-Rowsell in his initial informal WT4.3 fieldwork paper dated 08.12.10).

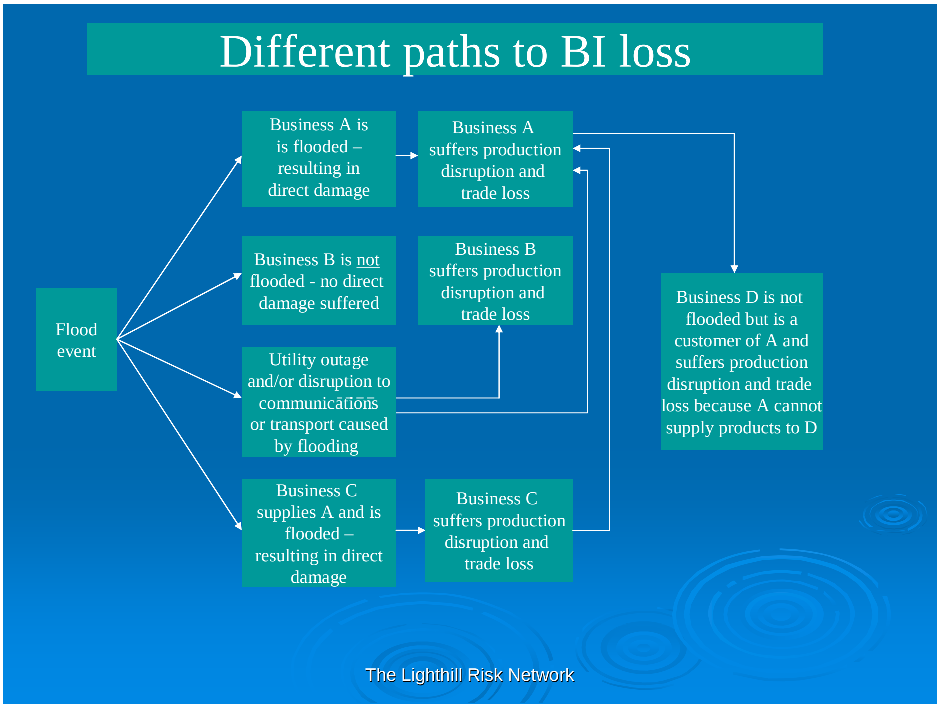

Figure 12: Business disruption linkages (Parker 2007)

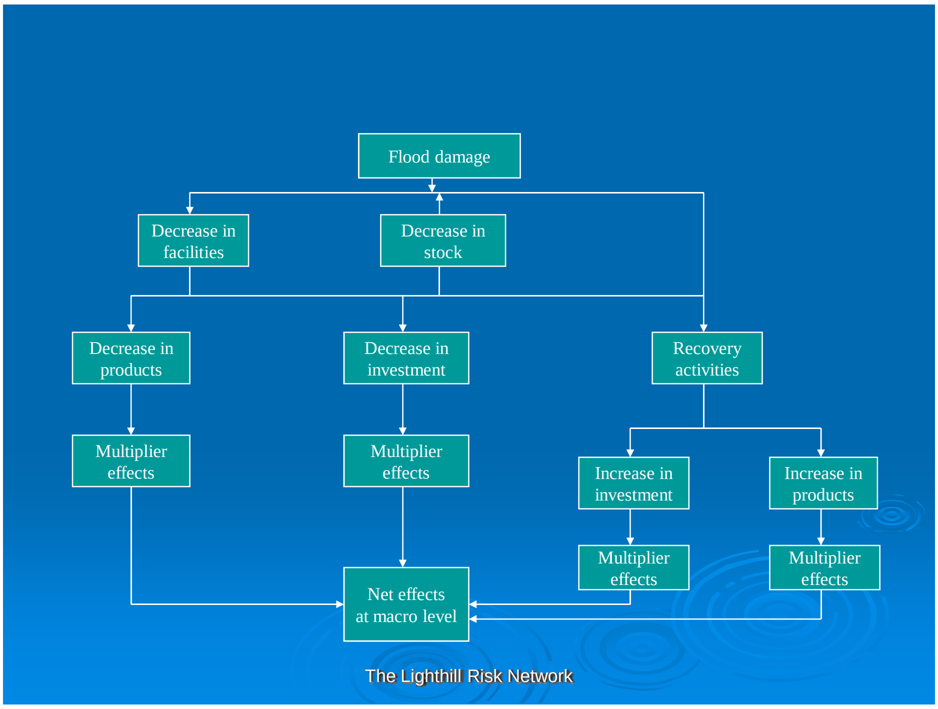

Figure 13: The countervailing effects of flooding on businesses (Parker 2007)

The literature on vulnerability and resilience is large, heavily laced with conceptual development and discussion and it is related to the literature on uncertainty. It is well beyond the scope of this paper to review and assess the implications of this literature. However, it is likely to contain some significant implications for THESEUS including T4.3. A useful starting point is the substantial discussion of vulnerability and resilience theory concepts in relation to natural and na-tech hazards developed by the ENSURE research project (Galderisi et al., 2010). This draws on a large range of literature notably including that of Holling (1973, 2001), Handmer and Dovers (1996) and Berkes (2007). For example, this research evaluates concepts which are similar to, or which could be a part of, resilience such as memory, learning capacity, transformability, diversity, spatial scale interaction, creativity and feedback, all of which have relevance and applicability to BC/DR. In another example from Galderisi et al. (2010) resilience is viewed as more than recovery and as a creative opportunity (Figure 14 below) aimed at achieving a higher level of functioning. Resilience is sometimes defined as the ability to return to a stable steady-state following a perturbation but in disaster recovery it is important that recovery is creative and uses the opportunity to avoid returning to the status quo and to move to a less vulnerable state. The implications for WT4.3 fieldwork include lines of questioning on:

- mechanisms for learning and storing learning (i.e. memory) from all experiences of all disruptive events;
- how disruptive events may be or have been capitalised upon to transform the resilience of businesses;
- using diversity (e.g. of supply chain sources; data storage sites) to enhance resilience;
- examining business linkages across scale (see below);
- the extent to which BC/DR is used in creative mode;

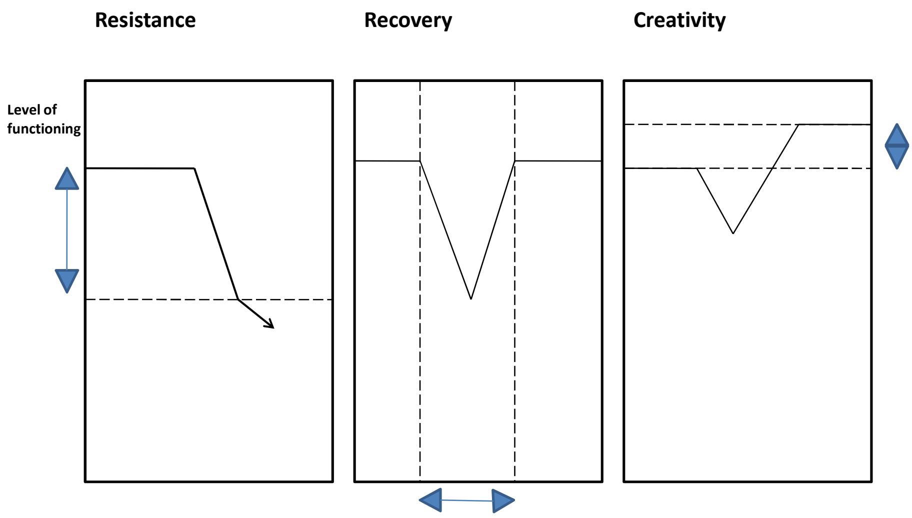

Figure 14: Properties of resilience adapted from Adger (2000) and Maguire and Hagan (2007). Source: Galderisi et al. (2010)

- the role of feedback mechanisms during emergencies; and
- the extent to which businesses perceive and act upon opportunities to be creative and to move to a more resilient position using BC/DR and/or following a disaster.

Further lessons from the ENSURE project

ENSURE is the acronym for the EU funded research project entitled 'Enhancing resilience of communities and territories facing natural and na-tech hazards' (2008-11). The aims of this project are to (1) develop a deeper understanding of the vulnerability of exposed systems to natural and na-tech hazards; (2) develop an integrated vulnerability assessment method; and (3) thereby to identify ways in which mitigation strategies and particularly resilience to hazards may be enhanced in future. This is an enormously complex project from which results have yet to be distilled by the research team.

To study resilience is to study vulnerability

An initial lesson from the project is that it is virtually impossible to research resilience without also researching vulnerability: the two are core, linked concepts and in turn have their links to similar concepts such as sustainability. The literature is full of discussion of these closely inter-related concepts (Adger, 2003; Fiskel, 2003; Gallopin, 2006).

Resilience is a complex and contested concept

There are major multi-disciplinary debates surrounding both resilience and vulnerability. For example, the ideas of Holling (1973, 1996, 2001) are influential in the resilience field. Holling stigmatizes the "ability to return to a stable steady-state following a perturbation" as defined by Pimm (1984), as engineering resilience, putting it in opposition to an ecological resilience. Whereas engineering resilience emphasizes efficiency, constancy and predictability aspects, ecological resilience emphasizes the persistence (maintaining existence of function) and robustness (preservation of the structure of the system in the face of perturbations) aspects (Table 7 below).

Table 7: Engineering and ecological resilience (extracted by Folke (2006)

Resilience concepts	Characteristics	Focus on	Context
Engineering resilience	Return time, efficiency	Recovery, constancy	Vicinity of a stable equilibrium
Ecological resilience	Buffer capacity, withstand shock, maintain function	Persistence, robustness	Multiple equilibrium states, stability landscapes

The "engineering" attribute is chosen by Holling according to the common approach of engineers aimed at designing systems with a single operating objective. Engineering resilience is permeated by "an implicit assumption of global stability, that is, that only one equilibrium steady state exists, or, if other operating states exist, they should be avoided by applying safeguards" (Holling, 1973). In the socio-institutional field, the political scientist Wildavsky (1985) takes into account two different ways of coping with uncertainty: anticipation and resilience. Whereas "anticipation relies on detecting problems and trying to avoid them" (Handmer and Dovers, 1996) and seeks to preserve stability, "resilience accommodates variability" (Wildavsky, 1988). Extending this line of thought, Handmer and Dovers adopt resilience as a useful concept for defining responses to ignorance/uncertainty and risk. In detail, the authors single out two typologies of strategies:

Resilience as the flip side of vulnerability is contested

The concepts of vulnerability and resilience are related, but the specific nature of the relations is not so obvious. It has been highlighted that the term vulnerability has evolved from a rather negative concept to a concept that relates directly to more positive notions such as resilience and adaptive capacity. Moreover, the traditional interpretation of vulnerability as the reciprocal of resilience is more and more challenged and replaced by notions considering resilience as an integral component of vulnerability or considering vulnerability as the static propensity and resilience as the dynamic propensity of a system in relation to a threat. A key-point arising from the relationships among vulnerability and terms as resilience and adaptive capacity is the dynamic character, including aspects such as the learning capacity within the vulnerability and resilience concepts.

Vulnerability and resilience have cross-scale implications

Scale is a key consideration in vulnerability and resilience. Hazard vulnerabilities and impacts propagate cross-scale and so do resiliences. Strategies and policies designed to increase resilience must take these scale implications into account and have their own cross-scale impacts and implications.

Resilience to complex hazards is an increasingly important consideration

A key part of the ENSURE project is the recognition of the increased occurrence of complex hazardous events, such as na-tech events. This has particular relevance for coastal hazards in which erosion, mass movements and flooding may be linked and in which 'natural' events can trigger 'na-tech' events. In urban areas, hazards are shifting from individual phenomena towards "an interactive mix of natural, technological and social events" (Mitchell, 1999). Moreover, the complexity of modern disasters, characterized by diverse phenomena with a greater potential for adverse impact is stressed by McEntire et al. (2002). There is a need for new methods aimed at providing a "reliable quantitative estimation of individual and coupled events" (Lipiatou and Peter, 2009).

Three macro-typologies of complex hazardous events can be distinguished:

- a first one refers to hazardous events that act as a sequence of repeated events of different type (e.g. coastal erosion, floods), or even to sequences of hazardous events of the same typology (e.g. floods), occurring in different points of the same geographical area at different times (multi-site events);
- a second one refers to events that, with reference to a given time span, are characterized by a sequence of phenomena, different in nature and features, such as pluvial floods leading to fluvial floods combined in some cases with groundwater flooding and/or tidal flooding (some of these sequences occurred in the summer 2007 floods in England);
- a third one refers to chains of events, in which, a triggering hazardous one induce other natural or technological hazards (the 2011 Japanese tsunami is a classic example; and in the summer 2007 floods in England, flooding led to a widespread, severe drinking water shortage lasting several weeks because water treatment plants were inundated).

The ENSURE project contains a detailed case study of a chained, na-tech coastal event. This is the storm surge flood accompanying Hurricane Katrina which affected the St Bernard's Parish area of New Orleans and which led to an oil storage tank farm being inundated in which one oil storage tank floated and spilled its oil causing a huge oil contamination disaster seriously affecting thousands of homes.

The expected outcome of the ENSURE is an integrated multi-scale, multi-hazard tool for assessing vulnerability and resilience to natural and na-tech hazards including enchained events.

Public/private flood impacts and recovery provesses

Business Impact Analysis (BIA), which is a key component of BC/DR planning, requires a searching analysis of the impacts of flooding and other coastal processes on a business entity and its relationships with other businesses, both in the supply chain (i.e. upstream impacts) and on the customer side (i.e. downstream impacts). In order to undertake a BIA it is routinely necessary to examine the interconnections between businesses and the manner in which flood (or other coastal processes) impacts may propagate through the business community and beyond into society. Impacts on society are something that many businesses wish to avoid or to minimise for reasons of self-interest (e.g. reputation, maintenance of goodwill, maintenance of prosperity and growth potential etc.) and/or corporate social responsibility (CSR). An analysis of business recovery processes, which is part of a businesses BDR plan, would require analysis of such interconnections in a business recovery mode.

The analysis of private flood impacts and social recovery processes opens up a complicated set of potential business relationships (see following table 8). Initially businesses may be categorised as (a) private and (b) public businesses. Recovery processes can also be considered to operate in the private and public sector with inter-connections between both.

In practice analysing these relationships, especially the ones between the private and public sector and the ones between the business sectors and society (i.e. social impacts), is potentially quite complicated. Division of business entities into private or public only provides a crude distinction between types of business which are encountered in Europe. Iin reality there are many forms of business enterprise with varying degree of private and public ownership and these forms vary from EU member state to member state. Businesses which have shareholders who may suffer a decline or loss of income as a result of a disaster will have a social impact (i.e. upon the shareholding class). Each of the eight THESEUS study sites will have its own particular set of business types which will determine the particular relationships and interconnections which will play out in a flood or other coastal disaster. The implication is that, in order to analyse these interconnections in any detailed manner in any location, and to examine the potential linkages between private/public and economic/social impacts and recovery processes, it is necessary to be aware of the types of businesses present because this affects their connections and disruptive impacts as well as recovery processes.

Table 8: Examples of potential (a) economic and social impacts of coastal flooding and (b) recovery processes in the private and public business sectors

	Economic	**Social**
Private sector enterprise e.g. a boat building and repair company; private fishing company	**Impacts e.g.** *Loss of profit impacted owner's income* *Loss of business to a private sector competitor* **Recovery e.g.** *Transfer of business to a free-flood site in order to allow recovery at flooded site to restore profitability of business*	**Impacts e.g.** *Loss of business leading to lay-off of workers* **Recovery e.g.** *Owners may elect to continue to pay staff during 'lay-off' period as a way of maintaining goodwill with staff and to help protect families from adverse impacts*
Public sector businesses and social enterprises e.g. a port authority (passenger logistics, navigation, cargo handling etc.)	**Impacts e.g.** *Loss of business to either public or private sector competitor* *Loss of revenue and decrease in profits* **Recovery e.g.** *Injection of revenue by Government holding company to help overcome disruption of business and to aid recovery of profitability*	**Impacts e.g.** *Port activity is disrupted leading to knock-on effects in other port dependent business (potentially both private and public sector), leading to lay-off or workers and rising local unemployment with social welfare implications* **Recovery e.g.** *Government compensation scheme for flood affected public businesses and affected families is activated – Europe's Social Solidarity Fund is the ultimate source of funding*

Table 9: Examples of types of private and public/social businesses in 3 European member states

Member state	**Examples of business types**
UK	• Sole proprietorship/Sole trader • Ltd. a private company limited by shares, the shares not being traded publicly • PLC a public limited company, a company whose shares may be traded publicly. • CIC or community interest company (may be adopted for example by social enterprises) • Industrial and Provident Society, e.g. a Co-operative (which does include Ltd. at the end of its name) or charity

France	• Partnerships (société de personnes):
	  o SNC (Société en nom collectif): general partnership (GP)
	  o SCS (Société en commandite simple):limited partnership (LP)
	  o SCA (Société en commandite par actions):publicly traded partnership
	• Companies (*société de capitaux*):
	  o SARL, SàRL (Société à responsabilité limitée): private limited company (similar to Ltd company in the UK)
	    ▪ EURL (Entreprise unipersonnelle à responsabilité limitée): single member company (no equivalent in the UK)
	  o SA (Société anonyme): public limited company (similar to PLC in UK)
	    ▪ SCOP (Société coopérative de production): co-operative
	    ▪ SEM (Société d'économie mixte): semi-public company
	• Auto-Entrepreneur: (similar to sole proprietorship in the UK)
	• EI (Entreprise individuelle/entreprise en nom personnel): (similar to sole proprietorship in the UK)

Germany	• GmbH (Gesellschaft mit beschränkter Haftung): (similar to Ltd company in the UK). • KG (Kommanditgesellschaft): limited partnership • KGaA (Kommanditgesellschaft auf Aktien): master limited partnership or publicly traded partnership • GmbH & Co. KG and GmbH & Co. KGaA: a special type of Kommanditgesellschaft in which the general partner is a GmbH. The GmbH & Co. KGaA it is a variant with shares. • AG & Co. KG and AG & Co. KGaA: a special type of Kommanditgesellschaft in which the general partner is an Aktiengesellschaft. The AG & Co. KGaA is a variant with shares. • OHG (Offene Handelsgesellschaft): general partnership. • GbR (Gesellschaft Bürgerlichen Rechts): partnership under civil law, small-business activities only. • Partenreederei: A form of combined and continued ownership of a single merchant vessel. • PartG (Partnerschaftsgesellschaft): type of partnership available to certain professions like lawyer, physician or tax consultant and similar. Similar to a limited liability partnership. • e.G. (eingetragene Genossenschaft): cooperative

Implications

With a focus on BC/DR planning, and with BIA being at the centre of the small umbrella of techniques which BDR planning incorporates (i.e. (1) Risk or threat analysis (2) BIA (3) Recovery planning), it is appropriate to adopt a conceptual framework which allows linkages between businesses to be identified. Not do so would be to unhelpfully truncate the BIA and to miss potentially significant flood (and other coastal process) impacts. This therefore indicates that a conceptual framework needs to be adopted which has similarities to the third model in Edmund Penning-Rowsell's paper of 8-12-2010 (i.e. Figure 1 in that paper). This does not mean to say that, for example, Wardekker et al's. (2009) ideas about resilience of systems cannot also be incorporated into such a conceptualisation. In fact these conceptualisations appear to be entirely compatible.

An issue arises about how far to take BIA and how far to expand the analysis of recovery planning into the social field. This relates also to how far to go down the route of carefully differentiating business types (as in Table 9 above) in order to understand how disruptive events will impact them and those to whom they relate. Although many may be private enterprises, businesses are fully part of the economy and society and cannot easily be separated from them unless some potential impacts are to be ignored. This is because impacts of floods upon both private and public companies will affect not only the business but also the economy and members of society (the latter may be employees, families of employees, customers or suppliers).

As far as business disruption recovery is concerned, it is clear from the literature that private companies have a variety of interests in helping to ensure that a local economy and community are able to recover as quickly and as fully as possible from a disruptive event. They also have an interest in ensuring that public sector businesses recover effectively especially, but not only, where these are infrastructure providers or customers. Not all will perceive these interests as fully as others and many are likely to much less engaged, or not at all engaged, in taking measures to help recovery in a wider sense. Smaller businesses are likely to be totally preoccupied with survival recovery, whereas larger businesses are likely to be those who will be able to convert their social responsibilities into social recovery actions. Collective BC/DR planning is quite common among businesses and their supply chain partners because businesses have a strong interest in making sure that their operations are not disrupted by interruption or loss of supply of vital components. They therefore often require business partners to have BC/DR plans, or if they do not do this they are likely to be satisfied that they have adequate alternative sources of components on tap. Beyond this, currently, it is unlikely that business outside of business groups (which may have a common approach to BC/DR) will engaged in any other form of collective BC/DR planning, for example with local chambers of commerce and business development agencies. It is also unlikely that business will be engaged in any form of social recovery planning. However, such planning might be appropriate in coastal communities where the threat to business is significant and where contingency planning is developed innovatively in this manner. Indeed, such a concept of collective BC/DR planning might be proposed as an innovative resilience measure for coastal communities.

In locations where the flood prone coastline or estuarial margins are narrow e.g. where land rises rapidly in an inland direction (e.g. parts of south Devon where there are drowned valleys (rias) and coastal slopes are convex in places) the social recovery aspects are likely to be much less significant than in locations where the flood prone coastline or estuarial margins are wide and extensive and where land levels are either below sea level (as in much of The Netherlands) or very close to sea level such that flooding can penetrate a long way inland (e.g. deltas, some large estuaries). Clearly in cases where flooding is extreme and penetrates a long way inland (e.g. New Orleans, Katrina event; Northern Japan, 2011 tsunami event) business recovery is fully part of the social recovery process. In the first case, it is perhaps defensible to consider BC/DR planning largely separately from social recovery planning, but in the second case the two are barely distinguishable and would need to be considered in an integrated manner.

Governance implications of BC/DR

Regulatory bodies and auditors play a significant part in driving uptake of BC/DR planning. They now routinely place expectations and requirements on businesses to plan fully for business disruption. Companies are increasingly expected to make a statement in their annual financial accounts to the effect that they have Business Continuity Plans in place. Corporate social responsibility (CSR) is also significant driving force for BC/DR planning take-up, stemming from businesses' desires to demonstrate that they a good corporate citizens, that they have a social conscience and that they behave ethically. Shareholders and customers are increasingly looking to do their business with ethically responsible businesses and so a degree of public pressure, or governance, is exerted through these channels and through social accounting again with effects being translated through the market mechanisms.

Many large business corporations will have almost certainly developed their BC/DR planning to a level where there is a form of collective BC/DR planning among them and their supply chain business partners and possibly also their customer partners. It is now common for both public and private sector businesses to require those bidding successfully for contracts from them to demonstrate that they have in place particular business processes, including BC/DR planning. This leads to BC/DR planning take-up and represents a form of collective planning. Small businesses are much less likely to have done this so that not only may there not be BC/DR plans in place, but there are likely to be few collective BC/DR plans, although pressures should be being increasingly exerted upon them in contract bidding processes. This form of collective planning is, in essence, brought about by market mechanisms i.e. businesses are excluded from the market if they fail to comply with expectations.

Governmental organisations, at local, regional and national levels (e.g. City Councils) are capable of exerting BC/DR planning take-up pressures in this way. In so far as governmental institutions may have elected representatives as well as appointed officials on their decision-making bodies, there is a potentially significant role in democratic representation of wider social interests in BDR planning. How far in reality this process works, and whether it works effectively in coastal communities, is currently unknown. These kinds of linkages are likely to be tenuous. At this stage it is also not known whether local business support groups (such as the local chambers of commerce in the UK) are in any way effective at organising a collective approach to BC/DR planning among businesses in their areas, although they are likely to promote BC/DR planning.

At this stage it would appear that the strongest governance pressures for effective BC/DR planning probably come from large corporations including multi-national corporations and medium-sized businesses and in the way explained above. The trickle-down of these pressures into small businesses is likely to be very imperfect as evidence indicates that small businesses are the least likely to have adopted BC/DR planning.

Notwithstanding the current wider issues surrounding governance in flood and coastal erosion management, governance implications arise from BC/DR. Firstly, coastal hazard/risk events have adverse spillover effects from the private to public sector and vice versa and the propagation of impacts through supply chains and on the customer side means that there can be many business stakeholders including ones which are not local. Secondly, an effective BC/DR process may require inputs from both the private and public sectors which will be, to varying degrees, dependent on each other during the recovery phase. For example, slow recovery by damaged and disrupted public sector businesses (e.g. highways authorities) may well magnify the recovery problems of private businesses who provide services and products to these public sector businesses, or who rely upon the services of public sector businesses. Business disruption can also clearly have social impacts (such as the laying off of labour) which may have implications for local communities thereby potentially greatly extending the range of stakeholders. The picture of the range and type of BC/DR stakeholders which emerges from this analysis introduces questions about what sort of inclusive decision-making processes are currently in place and be appropriate in future for BC/DR.

BC/DR planning appears to be almost exclusively funded from businesses' internal resources and finding the resources to undertake and maintain effective BC/DR plans appears to be a real struggle for small businesses in particular yet their disruption can have significant adverse local economic and social impacts. This raises a possible question about whether it makes sense for an element of public resourcing of such BDR planning possibly through some kind of local taxation advantage to encourage BC/DR take-up in small businesses in at-risk communities. Public resourcing of recovery from flood damage and disruption already exists (e.g. the Bellwin Scheme in the UK, and the EU Solidarity Fund etc.) but the extent to which such funding is preventative rather than reactive is an issue for the future. Currently, this kind of funding appears to be reactive only.

Implications of BC/DR for investigating businesses

The available BC/DR knowledge as reviewed here has a series of further implications for WT4.3 fieldwork and these are set out below.

Apart from establishing whether or not a business:

a) has experienced business disruption of any kind (including through flooding) (there is evidence from 2004 that BC/DR adoption varies between EU countries and that Swedish, UK and German businesses are most likely to have a BC/DR in place whereas significantly fewer French and Italian companies had then adopted BC/DR (www.continuitycentral.com/news0963.htm;);

b) whether or not the business has developed a BC/DR plan and has adopted business standards for IT/data systems and BCP (whether or not there is a regulatory requirement underpinning adoption), and

c) has recently audited or had audited its compliance with Business Continuity standards or its BC/DR arrangements -

BC/DR planning will probably need investigating through fieldwork by considering the following areas.

- the extent to which the business employs (i) Risk or Threat Analysis and (ii) Business Impact Analysis (BIA) (or a similarly named process) to understand the risks of disruption to the business and its likely consequences. It is likely that more businesses will have undertaken (i) than (ii).
- whether the business has adopted physical flood resistance and resilience measures (Bowker, 2007; Christopolos, 2006);
- the likely impacts of flooding disruption on the business. A full analysis of these impacts would amount to a BIA which we cannot expect to be undertaken by the fieldwork process but it should be possible to identify the following:
    - differentiation of critical (urgent) and non-critical (non-urgent) organisational functions or activities (as in BIA) and their location on the ground floor and/or upper floors;
    - identification of the location of each of the businesses buildings, including branch-plants or depots elsewhere;
    - identification of absolutely essential plant and equipment and its location regarding vertical height; also its susceptibility to floodwater damage;
    - identification of whether or not flooding can lead to loss of access to a businesses buildings;
    - the location of alternative spaces to evacuate key plant and equipment, raw materials and finished goods including off site (firms often underestimate the amount of space required for this contingency);
    - key utility functions on which the business is reliant and the existence of contingency plans for alternative sources of supply of electricity, water, telecommunications etc.;

- the establishment of recovery time objectives (RTOs) for each critical function and the resources required to achieve these;
- supply chain linkages and impacts (how the business can be affected by the loss of its suppliers owing to flooding either of their sites or access to them);
- how the business can safeguard its supply chain from disruption by diversifying its suppliers or having reserve suppliers (with credit checks, purchase accounts and other arrangements in place in advance) and/or by requiring its suppliers to have BC/DR plans in place;
- ensuring banks on which the business relies have alternative sites and ensuring that critical bank account information and details of creditors and debtors (invoicing) is replicated/ stored elsewhere;
- customer linkages and impacts (how the business can have its operations disrupted by flooding such that its customers are adversely affected including by possible product safety issues);
- information technology systems and data systems (how these may be adversely affected by disruption) and the degree to which they are critical to the business operation;
- the extent to which off-site back up IT systems (software and data replication methodology and arrangements) and data speedy data recovery;
- training of staff to deal with a flood emergency (do they know the critical items to move to higher ground first etc. ?);
- integration of flood warning arrangements into the BC/DR plans;
- the existence of plans for dealing with contamination by floodwater (salt, chemicals etc.) and related environmental compliance issues either by the company or suffered by the company;
- the impact of the loss of staff with key skills either because they are injured or are killed in a flood or because their homes are also flood prone etc.;
- arrangements for protecting staff (health and safety);
- the extent of insurance for direct and consequential flood loss;
- the extent to which the business is able to call upon the resources of a parent business to reduce disruption and aid recovery;

- o the existence of a crisis communication strategy and the means to implement it when business disruption takes place (communications with investors, suppliers, customers, shareholders, workforce); and
- o how the business communicates to guard against adverse publicity (media relations).
- o hazardous installations (e.g. nuclear sites; oil storage depots, toxic chemical plants) are usually required by law to have systems to alert the authorities of leakages or spillages or increased risks of explosion and similar problems, and they are also expected to have evacuation plans for on-site and off-site personnel.

The above considerations are used in the design of the Survey Guide (following chapter).

THE IMPLICATIONS OF SCALE OF EXPOSURE TO FLOODING AND OTHER COASTAL RISKS

The scale of exposure to flooding has a bearing on the issues which businesses are likely to face in business disruption and BDR planning, and in turn this has implications for the scope of the WT4.3 fieldwork. Broadly speaking there are two extremes with positions in between:

1. locations where the flood prone coastline or estuarial margins are narrow e.g. where land rises rapidly in an inland direction (e.g. parts of south Devon where there are drowned valleys (rias) and coastal slopes are convex in places);
2. locations where the flood prone coastline or estuarial margins are wide and extensive and where land levels are either below sea level (as in much of The Netherlands) or very close to sea level such that flooding can penetrate a long way inland (e.g. deltas, some large estuaries).

Naturally, businesses situated in “2” above may experience potential for much larger and longer duration disruption from flooding than businesses situated in “1” above. This is exemplified by the experience of the business community in New Orleans following the sea surge and flooding which accompanied hurricane Katrina (Richardson et al., 2008; Groen and Polivka, 2008). Katrina was exceptional because it devastated the centre of a major urban area, a vital transportation artery (the Mississippi) was disrupted, and US the energy production industry was affected in a major way.

Six impacts illustrate the exceptional effects on business.

- First, the local energy utility, Entergy Corporation, was severely affected, and the company was forced to file for bankruptcy protection in September 2005. Lower revenue and storm restoration costs were cited as the reasons. Permanent loss of connection was experienced by businesses because of the devastation in New Orleans. Entergy was refinanced by its parent company.
- Second, because people abandoned homes in large numbers, many of them permanently because they were totally destroyed, local tax revenues dried up, and local municipalities

experienced a severe drop in income. This had knock-on effects on their ability to employ people and so many were laid off.

- Third, small and medium size enterprises (SMEs) whose customers were mainly in the disaster area suffered a devastating loss of custom as business dried up. This led many businesses to bankruptcy.
- Fourth, businesses whose employees were mainly from the disaster area lost much of their workforces and suffered major losses.
- Fifth, the Port of New Orleans was closed for about four weeks. Exports piled up at the point of production leading to delayed and lost revenue.
- Lastly, the shrimping industry was lost owing to environmental damage.

GROUND TESTING THE BC/DR CONCEPTS IN THESEUS

WHO TO CONTACT IN BUSINESSES – TOWARD GROUND PROOFING THE CONCEPT

The BCI (2005) reports that where BC/DR plans are in place, they are developed and maintained by quite a wide range of employees (Figure 15 below). Overall, almost 60% of development and maintenance is done at Board level. 27% of companies are reported to have personnel dedicated to BCM but this is much more common in larger companies. Managing Directors tend to have more influence in smaller companies.

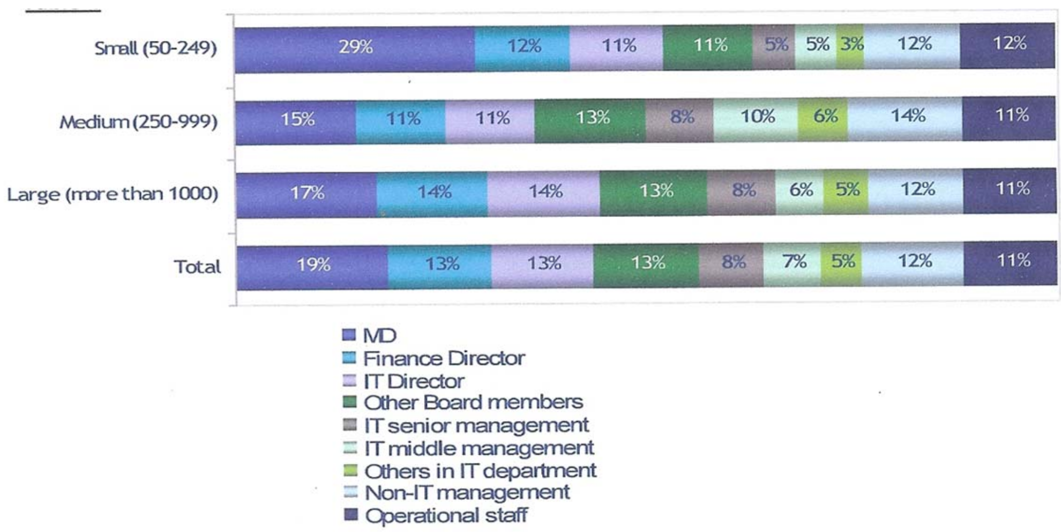

Figure 15: Ownership of Business Continuity Management in Small, Medium and Large businesses in 2005 (BCI, 2005)

There is evidence from 2004 that locus of ownership of BC/DR varies amongst European Countries. For example, Swedish businesses take BC/DR most seriously with it being owned by a Board Member (i.e. a Director) in 68% of companies whereas this percentage was 48% in Germany and 36% in the UK (www.continuitycentral.com/news0963.htm).

Applications to THESEUS study sites

Each study site will have its own unique mix of businesses but it is likely that the importance of some particular business sectors will be similar in each site. Tourism and fishing industries and port industries (e.g. storage, warehousing, recreational facilities, boat repair businesses, ferry terminals) in particular are likely to be present, as well as petro-chemical industries, power stations, other utility installations and naval bases. It is perhaps less likely that banking, finance and health sector businesses will be located in or close to port areas or in coastal risk zones.

Depending upon the particular set of businesses which may be disrupted by flooding and other coastal risks at any one time, the extent to which port operations – for the entry or departure of passengers and the import or export of goods – may be disrupted will be important to establish. Some ports may already be fairly resilient to flooding, whereas for various reasons others may not be. The dependence of businesses inland and away from areas at risk from flooding etc. on these port operations is an important question and immediately introduces the scale issue. Beyond this, most businesses may be investigated by fieldwork using the generic methodology which emerges from the considerations and implications set out in this paper.

Business disruption and recovery: survey guide

Aims

This survey guide is designed to collect data via interviews to help meet the aims of WT4.3. These aims are:

(a) To investigate the role that innovative methods of managing business operations could play in reducing the impact that hazards such as flooding bring to the coast and in estuaries.

(b) To investigate how far BC/DR methods might minimize the need for, or the design of , the kinds of major coastal and estuarine defence structures that otherwise would be needed in the future with climate-change induced sea level rise.

The survey guide focuses upon business disruption and recovery planning (BC/DR) but it also includes some questions on resilience and resistance measures which may be adopted with or without BC/DR. In some cases their adoption and installation may well be an outcome of BC/DR.

Conceptual underpinnings

A number of conceptual frameworks are drawn on here including Wardekker's conceptualisation. Wardekker's principles are 'keyed in' to the survey guide question types in italics in various places to illustrate this.

Sampling

The details of the sampling of business enterprises in this research are to be determined locally by THESEUS researchers active in the relevant study site, in consultation with FHRC. Discussions with Work Package colleagues at the May 2011 Gdansk meeting concluded that we should seek interviews with:

1. Local businesses (the majority of interviews)

2. Chambers of commerce/business organisations (1-2 interviews)

3. Local government authorities (regeneration agencies; spatial planners) (1-2 interviews)

The total target samples size was set at c. 10 interviews.

Secondaty source of data

Basic details of the businesses to be surveyed may be obtainable from local sources (e.g. in the UK, Kelly's Directory) or from statutory annual reports which companies (in the UK) must file and which are public information (in the UK available at Companies House in London and/or The British Library). However, the time and effort required to trace these basic details may not be worthwhile given that the details required for the survey can be obtained through the survey.

In depth, semi-structured interviews

The approach is to use fairly in-depth, semi-structured interviews. However, the aims are exploratory rather than focused on obtaining definitive responses and data for statistical analyses. It is tendencies, trends and ideas that are being sought rather than facts of figures.

WHO TO CONTACT TO ARRANGE THE INTERVIEW

Who to contact will depend on the size of the business and the country involved since this may vary between countries.

Ownership of Business Continuity Management in Small, Medium and Large businesses in 2005 (BCI, 2005)

- Data from the UK Business Continuity Institute for the UK (see above) suggests that in small businesses the Managing Director (MD) is the most likely individual to be esponsible for (i.e. own) BC/DR but that the Finance Director, IT Director and other Boards Members may well also be involved.

- For medium-sized businesses the MD is still the most likely individual to be responsible for BDRP but significantly less so than for small businesses. Again other Directors may 'own' this role.

- For large businesses the MD once again appears to be the most likely individual to 'own' BDRP along with other Directors.

However, it is also possible that IT senior and middle managers or other middle managers may ‘own’ BC/DP but it is unlikely that operational staff will have this role although some might.

It is also possible that there is a single owner or joint owners of a business and he/she/they may, in some circumstances, be the person(s) with the best understanding of business disruption and recovery.

There is evidence from 2004 that locus of ownership of BC/DR varies amongst European Countries. For example, Swedish businesses take BC/DR most seriously with it being owned by a Board Member (i.e. a Director) in 68% of companies whereas this percentage is 48% in Germany and 36% in the UK (www.continuitycentral.com/news0963.htm).

HOW TO APPROACH THE INTERVIEW

It is probably best to write a letter or email to a named senior individual (e.g. MD) in the business requesting an interview and indicating that a follow-up telephone call will be made to agree this and to make arrangements for the interview.

You will need to find and use the most likely term used in each country for BC/DR as a variety of terms are current (e.g. Business Continuity Planning, Business Disruption Planning, Crisis Management etc.).

The letter/email will need to give brief details of the THESEUS research project, its aims and the value of its outcomes, the funding agency and the purpose of the interview.

From the outset of contacts with companies, it may be best to explain that you are interested in business disruption from all sources (e.g, snow, epidemic, flood etc.) but that the focus is flood and related coastal hazards. This is because much of the survey is about generic processes. Companies may be fairly frequently contacted by BC/DR organisations seeking to find out information and therefore it will be important to make sure that they do not think that this is just another BC/DR survey.

It is worth remembering that nearly all businesses will have installed fire detection and resilience measures and this may be the best way into the subject. Remember also that many businesses in Europe will have encountered at least some disruption to their normal business operations because of the Icelandic ash cloud incident in April 2010 which severely disrupted travel, freight transport and communications for some considerable time.

During the telephone call seek a) to confirm who owns BC/DR in the business b) an interview that this individual or these individuals. If the business does not have a BC/DR then the interview remains relevant because it can be used to explore the potential value of such planning.

It is unlikely that an interview of more than one hour will be granted, but it is important to request a meeting of up to one hour’s duration. Try to keep the interview informal using a conversational approach rather than a mechanistic one. Maybe this can be done over lunch to which you buy for them (make sure it is a quiet place).

Seek to gain their permission to digitally record the meeting.

Try to cover all the question topics, even if this has to be superficial for some

Ask if you can follow up by telephone later if something has been missed.

Do not forget to explain to them when the THESEUS research project will be completed and how its results will be disseminated.

STRUCTURE OF INTERVIEW

The interview is structured around five themes:

Theme 1: Details of the business

- Company name, name of parent company or owner
- Type of company
- Description of the business and its principal products and services
- Size of business
- Number and location of sites
- Length of time at the interview site
- Whether or not the site benefits from structural flood or erosion defences

Theme 2: Experiences of business disruption or whether the business could be disrupted or interrupted by unscheduled events

This explores how the business has been disrupted by any type of event and is designed to get the respondent thinking and talking about the vulnerability of their business to disruption.

- This is about any form of disruption or interruption of business since BC/DR planning is almost always multi-hazard planning
- Details of the most recent experiences
- Whether or not flooding or coastal events have disrupted or could disrupt the business

Theme 3: The characteristics of business disruption owing to flooding (or other coastal events)

This explores how the business and its components may be disrupted by flooding etc. It is meant to be an overview Business Impact Analysis.

- How flooding
  - could affect the business
  - of one or more supply chain partners could disrupt the business
  - could affect employees
  - of infrastructure could affect the business
  - of information and data systems could affect the business
  - might adversely affect customers
  - could have other adverse impacts
- Plans to minimise each of the above

Theme 4: Business disruption and recovery planning

This explores the extent to which the company has engaged in BC/DR planning but not just for floods but to all unscheduled events.

- Whether or not the company has undertaken a risk analysis, engaged in Business Impact Analysis and constructed a BC/DR plan
- Whether or not the plan is tested and updated
- What are the main drivers for creating the plan.
- Collective planning of BC/DR
- Costs of BC/DR to the business

Theme 5: Other aspects

This picks up a number of important remaining issues.

- Extent to which a disruptive event can be viewed as a window of opportunity to move to a more resilient state for the future
- Existing adoption of resistance and resilience measures for flooding or other coastal process risk management
- Constraints to adopting such measures
- Whether or not the company has business disruption insurance

POST CRISIS MANAGEMENT AS A MITIGATION OPTION[5]

INTRODUCTION

The objectives of the WT 4.4 Post-crisis response are twofold: to collect specific information regarding post traumatic stress reactions and psycho-social needs for victims of coastal floods; and offer decision-makers a methodological guide and a coherent model for psychological and social support in the acute and in the transition phase of flooding.

A particular attention will be paid to the evaluation of indirect costs related to human lives. To this end it is necessary to brief overviews of the research base and recommendations concerning interventions for different time periods in the aftermath of flood disasters. Literature review and specific surveys in up to 4 selected sites (to be defined during kick-off meeting) will be performed.

A REVIEW OF MORTALITY FOLLOWING MAJOR FLOODS DISASTERS USING EM-DAT

For the purpose of this report we will gather data on disasters from the Emergency Events Database. EM-DAT EM-DAT (website http://www.emdat.be/ accessed on August 2010) is a worldwide database on disasters maintained by the Centre for Research on the Epidemiology of Disasters (CRED), with the sponsorship of the United States Agency for International Development's Office of Foreign Disaster Assistance (USAID/OFDA). CRED was established in 1973 as a non-profit institution located within the School of Public Health of the Université Catholique de Louvain (UCL) in Brussels.

EM-DAT was established in 1988, and it contains 18,000 disasters in the world dating from 1900, although the time period covered for each type of disaster varies. The database is based on the information provided by various sources, including UN agencies, non-governmental organizations, insurance companies, research institutes and press agencies. The priority was given to data provided by UN agencies, followed by OFDA, governments and the International Federation of Red Cross and Red Crescent Societies.

The following is the definition of disaster considered in EM-DAT: "situation or event, which overwhelms local capacity, necessitating a request to national or international level for external assistance". For a disaster to be entered into the database at least one of the following criteria must be fulfilled:

- Ten (10) or more people reported killed.
- Hundred (100) or more people reported affected.
- Declaration of a state of emergency.
- Call for international assistance.

[5] Section author: Luca Pietrantoni, Universityof Bologna

Disasters are classified in five subgroups: geophysical, meteorological, hydrological, climatological, and biological. Geophysical disasters are defined as events originating from solid earth and include the following disaster main type: earthquake, volcano, and mass movement (dry). Meteorological disasters refer to events caused by short-lived/small to meso scale atmospheric processes (in the spectrum from minutes to days) and include storm as disaster main type. Hydrological disasters are defined as events caused by deviations in the normal water cycle and/or overflow of bodies of water caused by wind set-up and include flood and mass movement (wet). Climatological disasters are those events caused by long-lived/meso to macro scale processes (in the spectrum from intra-seasonal to multi-decadal climate variability) and include the following disaster main type: extreme temperature, drought, and wildfire. Finally, biological disasters are caused by the exposure of living organisms to germs and toxic substances and include the following disaster main type: epidemic, insect infestation, and animal stampede.

EM-DAT data include the main following information:

- Disaster number: A unique disaster number for each event (8 digits: 4 digits for the year and 4 digits for the disaster number - i.e.: 19950324).
- Country: Country(ies) in which the disaster has occurred.
- Disaster group: Three groups of disasters are distinguished in EM-DAT: natural disasters, technological disasters and complex emergencies.
- Disaster type: Description of the disaster according to a pre-defined classification.
- Date: When the disaster occurred. The date is entered as follow: Month/Day/Year.
- Killed: Persons confirmed as dead and persons missing and presumed dead (official figures when available).
- Injured: People suffering from physical injuries, trauma or an illness requiring medical treatment as a direct result of a disaster.
- Homeless: People needing immediate assistance for shelter.
- Affected: People requiring immediate assistance during a period of emergency; it can also include displaced or evacuated people.
- Total affected: Sum of injured, homeless, and affected.
- Estimated Damage: Several institutions have developed methodologies to quantify these losses in their specific domain. However, there is no standard procedure to determine a global figure for economic impact. Estimated damage are given (000') US$.

In this database flood disasters include three kind of events: general river flood, flash flood and storm surge/coastal flood. General flood describes gradually rising inland floods (rivers, lakes, groundwater) due to high total depth of rainfall or snowmelt. A general flood is caused when a body of water (river, lake) overflows its normal confines due to rising water levels. The term general flood additionally comprises the accumulation of water on the surface due to long-lasting rainfall (water logging) and the rise of the groundwater table above surface. Furthermore, inundation by melting snow and ice, backwater effects, and special causes such as the outburst of a glacial lake or the breaching of a dam are subsumed under the term general flood. General floods can be expected at certain locations (e.g. along rivers) with a significantly higher probability than at others.

A flash flood describes sudden flooding with short duration due to intense rainfall. In sloped terrain the water flows rapidly with a high destruction potential. In flat terrain the rainwater cannot infiltrate into the ground or run off (due to small slope) as quickly as it falls. Flash floods typically are associated with thunderstorms. A flash flood can occur at virtually any place.

Storm surge/coastal flood describes the rise of the water level in the sea, an estuary or lake as result of strong wind driving the water towards the coast or the lake shores. This so-called wind setup is superimposed on the normal astronomical tide. The mean high water level can be exceeded by five and more metres. The areas threatened by storm surges are coastal lowlands.

Flood disasters around the world

According to the Emergency Events Database, from 1900 to 2010, disaster killed about 32 millions people around the world. Flood disasters are responsible for the deaths of almost seven millions of people. The mortality of flood disasters is the highest after drought and epidemic. Figure 16, below, depicts the trend of number of death caused by different natural disasters in the last 25 years. As we can see, compared to other natural disaster type disaster flood were relatively constant across this time period if we exclude a small peak in the years preceding the new century.

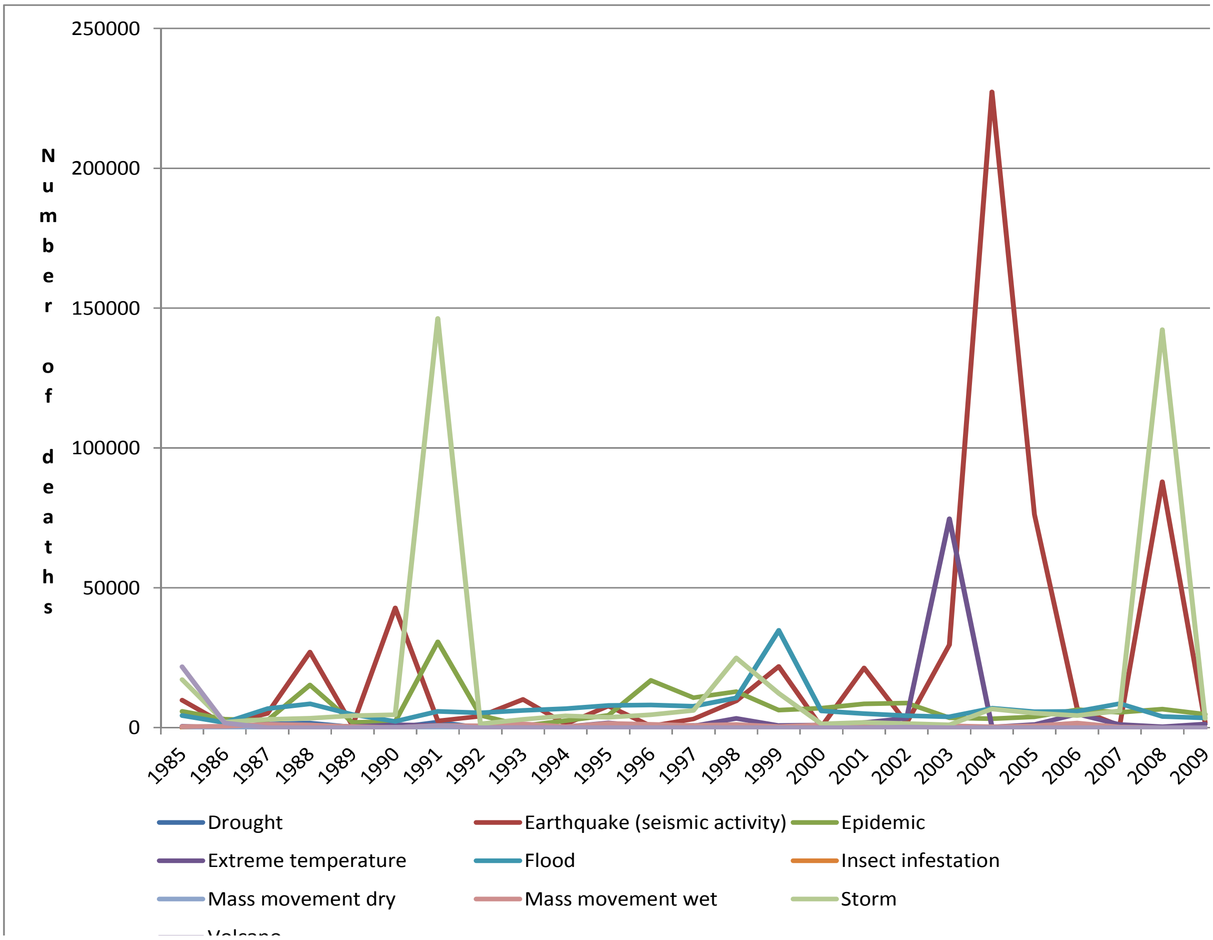

Figure16: Number of death caused by Natural disaster Type from 1985 to 2010

Table 10 below shows the number of floods disasters, mortality, number of people affected and damage sorted by continent from 1900 to 2010. As we can see the most affected continent in terms of mortality is clearly Asia with more than 98% of all people killed. Americas is, separated by a large distance, the second continent affected by number of people killed, accounting for about 1.5%. Europe is the last but one continent affected accounting for 0.12% of the number of people killed. The ratio of the number of people killed to the number of events showed that the most severe disasters happened in Asia (about 4.410 people died per event) followed by Americas (about 114 people died per event). Again Europe is the last but one continent affected by severe events (about 18 people died per event). In terms of people affected (people not killed) the highest number was in Asia followed by Americas. Again Europe was the last but one continent affected. As it was expected, the economic impact (estimated damage) was highest in Asia. It should be noted, however, that the estimated damages were particularly high in Europe, the second continent. The estimated damages were almost half of those in Asia.

Number of floods disasters, mortality, number of people affected and damage sorted in Europe from 1900 to 2010

	N. of Events	Killed	Total Affected	Damage (US$)
Unspecified	133	3289	4265569	24260105
ave. per event		24.7	32071.9	182406.8
Flash flood	40	1277	534759	12799150
ave. per event		31.9	13369	319978.8
General flood	289	1836	8262172	65947253
ave. per event		6.4	28588.8	228191.2
Storm surge/coastal flood	7	2028	615531	342622
ave. per event		289.7	87933	48946
Total	469	8430	13678031	103349130

Flood disasters in Europe

Figure 17, below, depicts trend in number of deaths due to flood in Europe from 1900 to 2009. The highest number of reported deaths was in the year 1953 due to The North Sea flood of 1953. In general during the first 75 years of the last century there were the highest numbers of victims. The mean number of reported deaths in the period 1900-2009 was about 144. In the last 20 years the mean number of reported deaths was about 90 each year. The number of affected people due to flood in Europe from 1900 to 2009 was particularly high during the ’60 and the ’90 (see Figure 18 below). In the last 20 years a mean of 313.828 people was affected by flood each year. In the period starting from 1900 to 2009, Netherlands, Romania, Spain, Italy, Portugal and Russia reported, respectively, the higher number of deaths due to flood (see Figure 19 below). The number of affected people was highest in Italy (close to three millions), followed by Ukraine, Russia and Romania (see 20 Figure below). In the period starting from 1900 to 2009, the European countries with the higher number of flood events were, respectively, Russia, Romania, France, and Italy, (see Figure 21 below). The total number of flood events in Europe in that period was 439. The mean number of people affected was 3435 for each flood event (cf Figure 22).

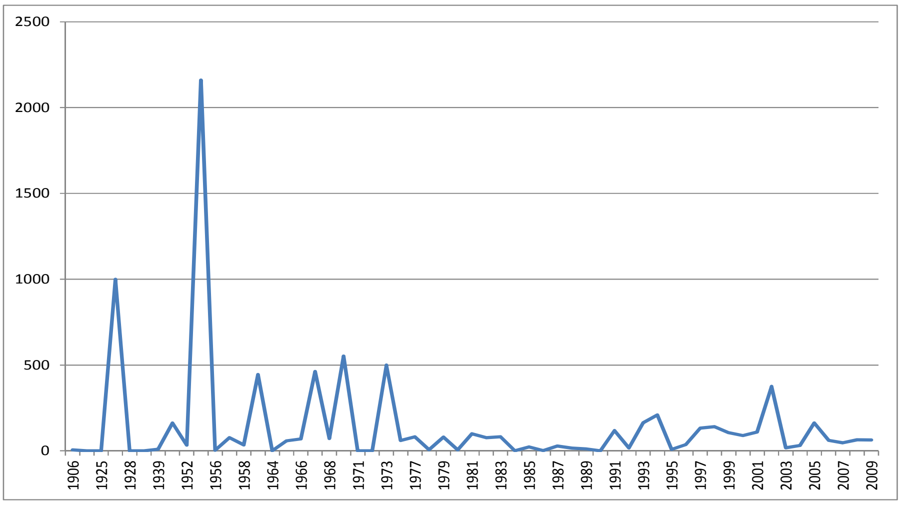

Figure 17: Trend in number of deaths due to flood in Europe from 1900 to 2009

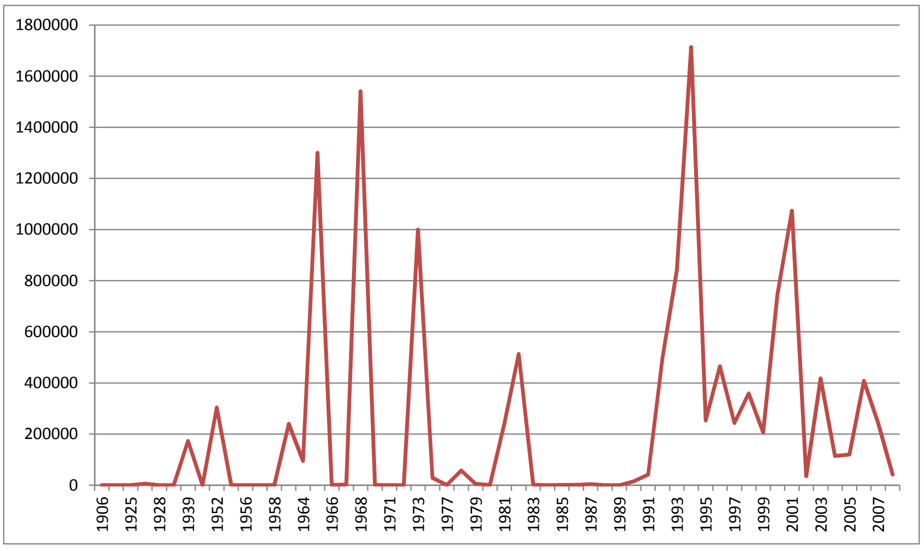

Figure 18: Trend in number of affected people due to flood in Europe from 1900 to 2009

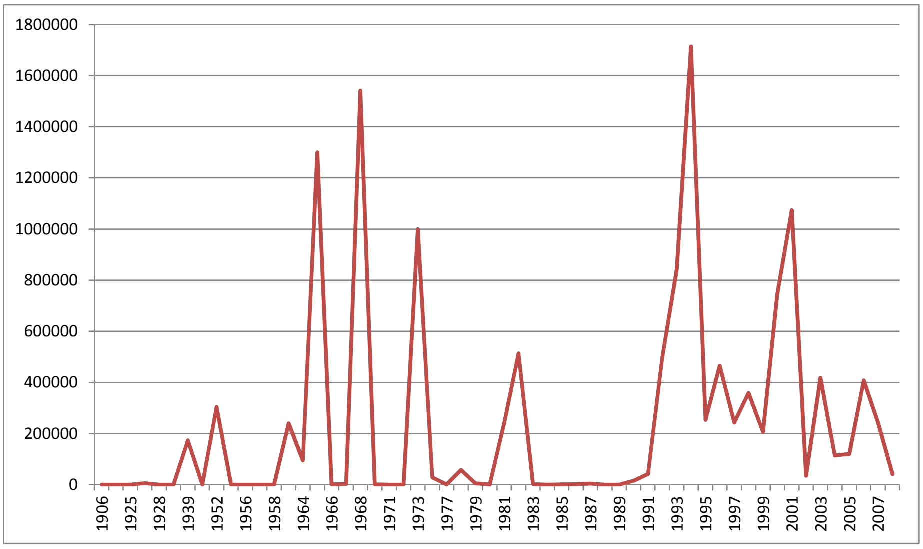

Figure 19: Number of reported deaths due to flood in European Countries in the period 1900-2009

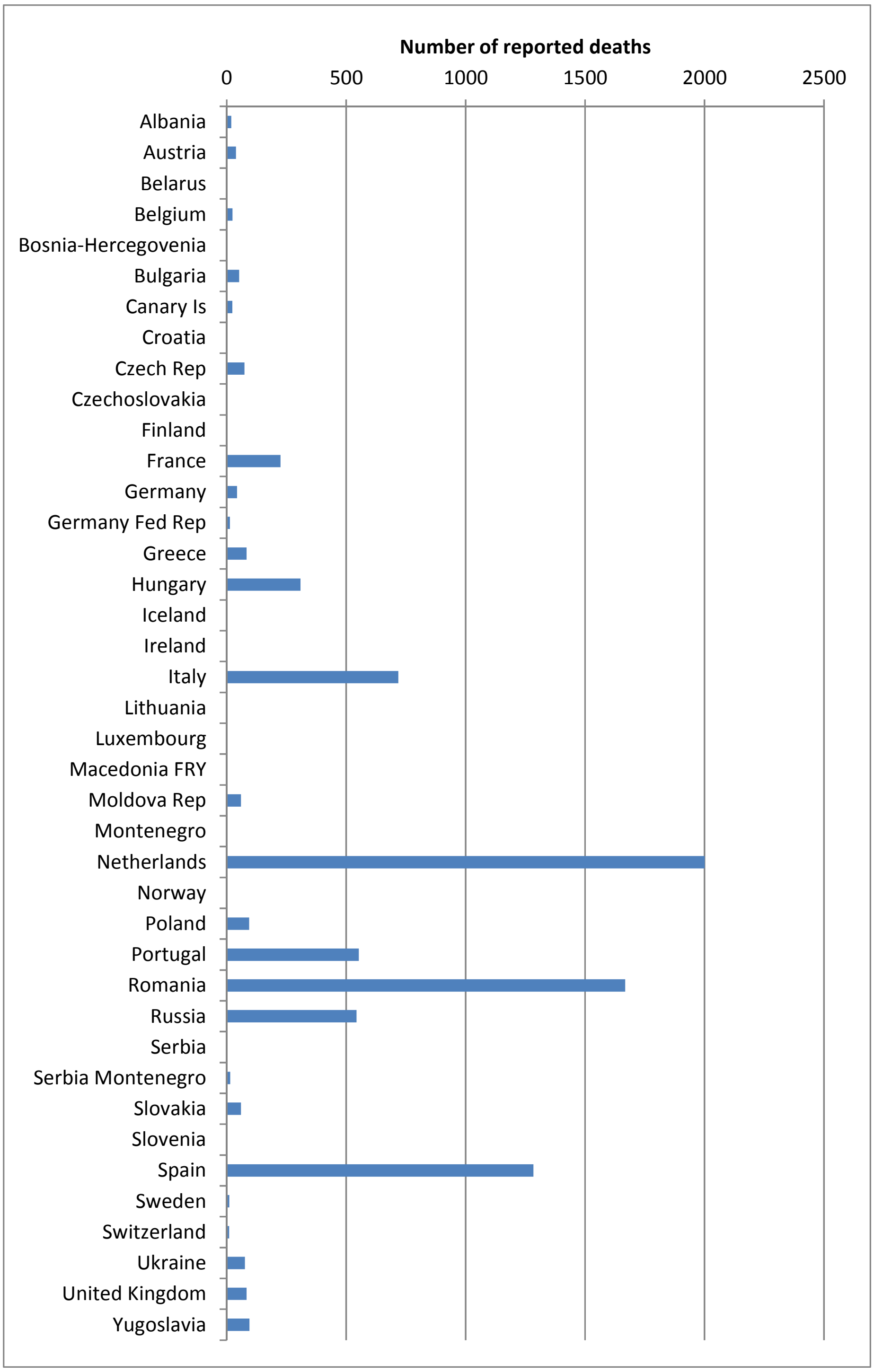

Figure 20: Number of reported deaths due to flood in European Countries in the period 1900-2009

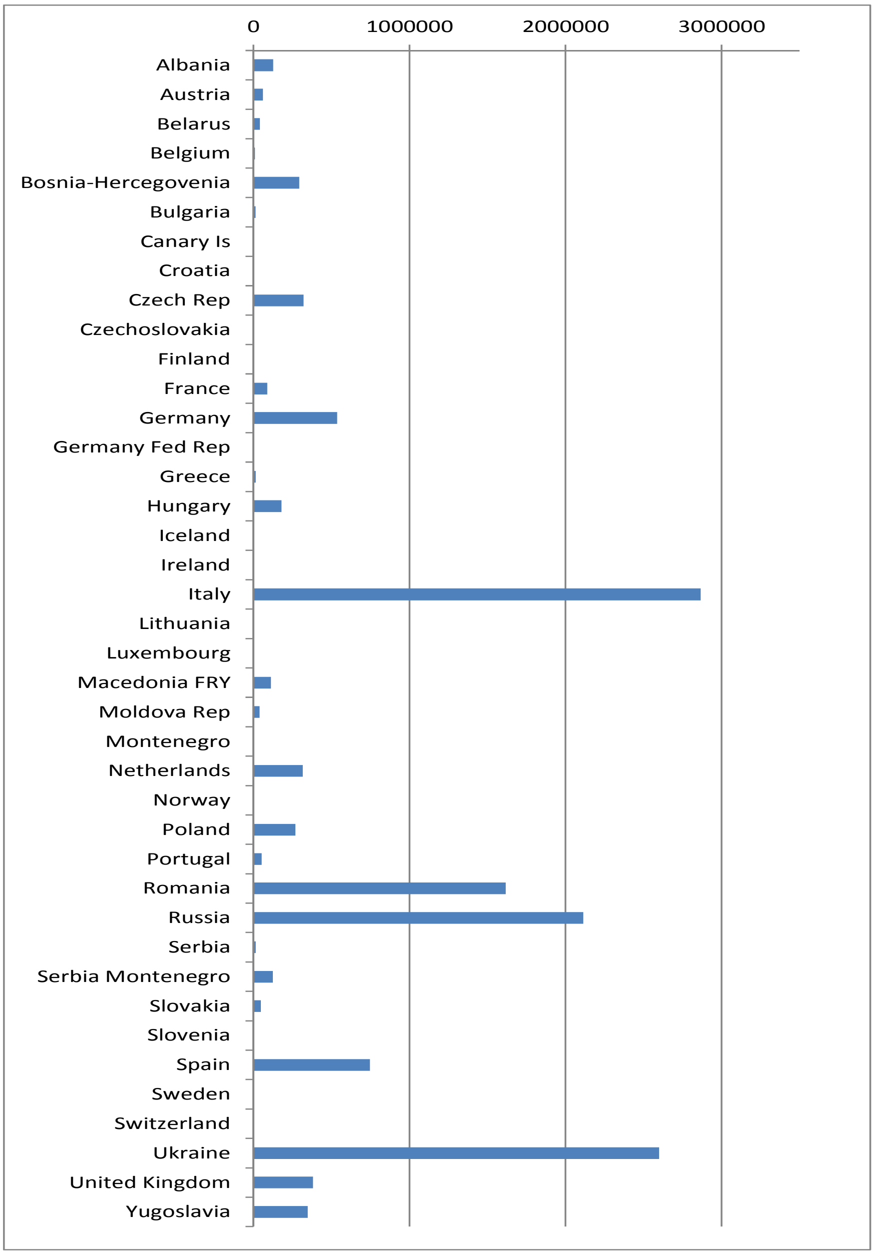

Figure 21: Number of affected people by flood disasters in European Countries in the period 1900-2009

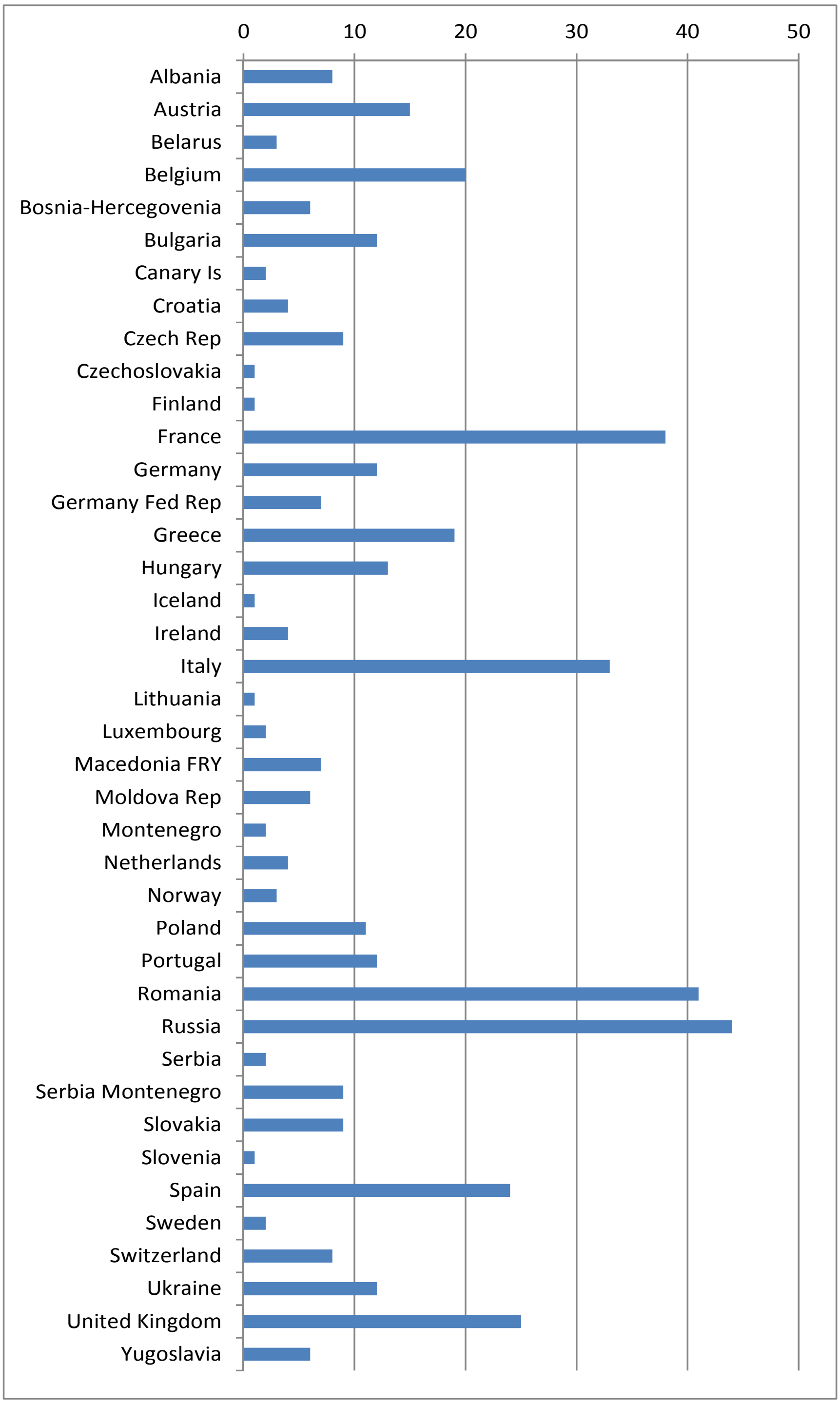

Figure 22: Number of flood disasters in European Countries in the period 1900-2009

Coastal floods in Europe

A large coastal flood was the worst natural disaster in the United Kingdom and the Netherlands.Over the centuries disastrous floods with significant loss of life have occurred every one to two hundred years. Climate change and the rise in the sea level could result in the frequency of these severe events increasing by an order of magnitude by the year 2050. In other words, the conditions for major coastal flooding could reoccur once every 10–30 years. The reference event for such disastrous coastal flooding was the Great Flood of 1953, the worst in recent times. The North Sea flood of 1953 (Dutch: Watersnoodramp: 'the flood disaster') and the associated storm combined to create a major natural disaster which affected the coastlines of the Netherlands and England on the night of 31 January – 1 February 1953. Belgium, Denmark and France were also affected by flooding and storm damage. The death toll from drowning was 307 100 died in E. Anglia and 58 on Canvey Island. In Holland, 1 795 died as the surge swept across the English Channel. The death toll would have been higher were it not for the efforts of 500 000 servicemen stationed in post war Britain at the time, along with their logistical back up and equipment.

Table 10: Storm surge/coastal flood disasters in European Countries in the period 1900-2009

Start date	**End date**	**Country**	**Region**	**Deaths**	**Affected**	**Est. damage (Us Million)**
31/01/1953	31/01/1953	Belgium	Ostende	11	350	
31/01/1953	31/01/1953	Netherlands	Zuiderzee area	2000	300000	300
20/12/1997	23/12/1997	Albania	Lezhe (North-Western)		8000	
00/08/2000	00/08/2000	Russia	Eastern Maritime region		6000	7
28/08/2000	28/08/2000	Russia	Bolshoi, Dalnegorsk		1181	1.622
07/07/2001	13/07/2001	Russia	Buryata, Irkutz	11	300000	33

Health impact of flood disasters

Among the natural disasters, floods are often cited as being the most lethal (Alexander, 1993; French and Holt, 1989). The aims of this report are to present findings from a wide-ranging review of global literature on health impact associated with flooding. In the present study we will focus on mortality and mental health outcomes. Although a comprehensive discussion of the meaning of disaster and disaster flood is beyond the scope of this report, we will use the working definitions provided by Jonkman and

Kelman (2005). Flood is defined as the presence of water in areas that are usually dry due to a significant rise of water level in a stream, lake, reservoir or coastal region. A flood may become a disaster (flood disaster) if its effects significantly disturb or interfere with human and societal activity. A fatality caused by a specific flood event is named flood fatality or flood-related fatality. Synonyms and related terms comprise, but are not limited to, 'flood deaths', 'loss of life in floods', 'flood mortality' and 'killed by flooding'. Limited data on flood events shows that the greatest "burden of mortality" is from drowning, heart attacks, hypothermia, trauma and vehicle-related accidents. The speed of onset of floodwaters is a determining factor in the number of immediate flood-related deaths.

Adverse effects on human health include the following:

- Trauma deaths, mainly by drowning. Drowning is the leading cause of death in case of flash floods and coastal floods. Fatal injuries can occur during evacuation or during cleanup activities.

- Flood-related injuries, such as contusions, cuts and sprains have been reported in several studies, as have burns, electrocutions, snake bites and wound infections. However, the number of serious injuries observed after violent flooding events generally turns out to be much lower than initial estimates predict.

- Enteric infections due to the disruption of sewage disposal and safe drinking water infrastructure.

- Increases in mental health problems such as anxiety, depression, sleeplessness, and post-traumatic stress disorder among flood victims. The risk estimates for physical illness in adults declined after adjustment for psychological distress, while psychological distress remained strongly associated with flooding after adjustment for physical illnesses.

- Vectorborne disease, such as malaria, dengue and dengue hemorrhagic fever, yellow fever, West Nile fever and rodent-borne disease, such as leptospirosis. There is some evidence that diarrhoeal disease increases after flooding, particularly in developing countries but also in Europe. Standing water caused by heavy rainfall or overflow of rivers can act as breeding sites for mosquitoes, and therefore increase potential exposure to infections such as dengue, malaria and West Nile fever among people affected by the disaster and among emergency workers. West Nile fever has emerged in Europe after heavy rains and flooding, with outbreaks in Romania in 1996-97, the Czech Republic in 1997 and Italy in 1998.

- There is also an increased risk of infection from diseases contracted through direct contact with polluted waters, such as wound infections, dermatitis, conjunctivitis, and ear, nose and throat infections.

- Contamination by toxic chemicals during floods is theoretically possible but no verifiable correlation has been observed or measured so far.

- Other negative health outcomes, for example related to the disruption of healthcare services and population displacement.

Table 11: Indirect effects of floods on human health

Causes	**Health implications**
Stream flow velocity;topographic land features;absence of warning; rapid speed of flood onset; deep floodwaters; landslides; risk behaviour; fast flowing waters carrying boulders and fallen trees	Drowning Injuries
Contact with water	Respiratory diseases; shock; hypothermia; cardiac arrest
Contact with polluted waters	Wound infections; dermatitis; conjunctivitis; gastrointestinal illnesses; ear, nose and throat infections; possible serious waterborne diseases
Increase of physical and emotional stress	Increase of susceptibility to psychosocial disturbances and cardiovascular incidents
Damage to water supply systems; sewage and sewage disposal damage; Insufficient supply of drinking water; Insufficient water supply for washing	Possible waterborne infections (e.g. hepatitis A, leptospirosis, giardiasis, campylobacteriosis); dermatitis and conjunctivitis
Disruption of transport systems	Food shortage; disruption of emergency response
Underground pipe disruption; dislodgment of storage tanks; overflow of toxic-waste sites; release of chemicals; disrupture of gasoline storage tanks may lead to fires	Potential acute or chronic effects of chemical pollution
Standing waters; heavy rainfalls; expanded range of vector habitats	Vector borne diseases
Disruption of social networks; loss of property, jobs and family members and friends	Possible psychosocial disturbances
Clean-up activities following floods	Electrocutions; injuries; lacerations; skin punctures
Damage to health services; disruption of "normal" health service activities	Decrease of "normal" health care services, insufficient access to medical care

Source: MENNE ET AL. Floods and public health consequences, prevention and control measures.

MENTAL HEALTH CONSEQUENCES OF FLOOD DISASTERS

The World Health Organization recognizes that the mental health consequences of floods have not been fully addressed by those in the field of disaster preparedness or service delivery,although it is generally accepted that natural disasters, such as earthquakes, floods, and hurricanes, take a heavy toll on the mental health of the people involved, most of whom live in developing countries, where [the] capacity to take care of these problems is extremely limited. According to Ahern et al. (2005), the main evidence relates to common mental disorder, posttraumatic stress syndrome, and suicide.

Most studies on the effects of flooding on common mental disorders are from high- or middle-income countries, including Australia , Poland, the United Kingdom , and the United States, but there is also a study from Bangladesh. Bennet's analysis of the 1968 Bristol floods found a significant increase (18 percent vs. 6 percent; $p < 0.01$) in the number of new psychiatric symptoms (considered to comprise anxiety, depression, irritability, and sleeplessness) reported by women from flooded compared with nonflooded areas, although there was no significant difference for men. These results broadly agree with the findings for the 1974 Brisbane floods, except that in Brisbane men were also affected. Those between 35 and 75 years of age suffered the greatest impacts.

Other evidence for impacts on common mental disorder comes from a controlled panel study of adults aged 55–74 years flooded in 1981 and again in 1984. Flood exposure was associated with significant increases in depression ($p < 0.005$) and anxiety ($p < 0.0008$) (and also physical symptoms), especially in those with higher levels of preflood depressive symptoms and in those from lower socioeconomic groups—a finding that Phifer et al. suggest supports Logue et al.'s 1981 assertion that 'low-income people are more vulnerable to the adverse effects of a disaster. In a longitudinal study, Ginexi et al. were able to compare symptoms for depression in both the pre- and postflood periods, and they found that, among respondents with a preflood depression diagnosis, the odds of a postflood diagnosis increased significantly. On the other hand, more equivocal evidence comes from two case-control studies of the mental health impacts of Tropical Storm Agnes, which caused extensive flooding in Pennsylvania in 1972. The first study, conducted 3 years postflood, focused on working-class males aged 25 - 65 years; the second, conducted 5 years after the event, focused on women aged 21 years or more. In both cases, respondents from flooded households reported more mental health symptoms than did nonflooded respondents, but differences were not statistically significant. The authors speculate that 'the failure to find a stronger relationship . . . may, in part, be the result of the length of time which had elapsed since the disaster impact'". Comparatively few studies have examined mental health impacts on children.

PTSD 'arises after a stressful event of an exceptionally threatening or catastrophic nature and is characterised by intrusive memories, avoidance of circumstances associated with the stressor, sleep disturbances, irritability and anger, lack of concentration and excessive vigilance [and the specific diagnosis of PTSD] has been questioned as being culture-specific, and may be overdiagnosed.

Nonetheless, studies showing increases in PTSD following floods come from Europe and North America. McMillen et al., who interviewed those affected by the 1993 Midwest floods, found that 60 subjects (38 percent) met the criteria for postflood psychiatric disorder and 35 (22 percent) met the criteria for flood-related PTSD. However, the limitations, recognized by the authors, included retrospective data collection, self-selection of interviewees, self-reporting, and the absence of a control group.

Similar limitations applied only to a study of 1997 flood victims in the Central Valley of northern California: 19 percent (24) of the 128 participants who completed the acute stress disorder questionnaire met the criteria for the disorder’s diagnosis, and of the 73 participants who completed the 1-year follow-up, seven (10 percent) met the criteria for full PTSD. Studies of the 1996 flooding in the Saguenay/Lac St. Jean region of Quebec, Canada, also suggest substantial increases in emotional distress and PTSD among flooded respondents.

Evidence from Puerto Rico and from work by Norris et al. (95) suggests that PTSD symptoms are influenced by the extent of flooding, culture, and age. The difficulties of interpretation are demonstrated in a study by Verger et al. (100), who examined the mental health impacts 5 years after the 1992 floods in Vaucluse, France. They concluded that the subjects’ reports of their disaster-related experiences (significantly worse for women and subjects older than 35 years) are by nature subjective and not entirely reliable.Studies focusing specifically on flooding in developed countries have reported similar findings (Smith, 1996). For example, Waelde et al. (1998) noted that victims of the 1997 floods in California evidenced symptoms of two stress disorders: acute stress and PTSD: both short- and long-term stress reactions. Phifer and Norris (1989) found the psychological consequences associated with personal property loss following flooding to be relatively short-term (less than 1-year), whereas exposure to widespread community destruction had a longerterm impact (up to 2 years), regardless of individual loss. Following flooding there may also be a community-wide tendency for people to feel less positive about their surroundings, less enthusiastic, energetic and less able to enjoy life. Evidence from the north of England suggests that flooding may impair the quality of community life for quite some time due to the disruption of community activities and a sense of community breakdown (Tapsell and Tunstall, 2001).

Flooding, in common with other traumatic life events, is associated with increased rates of the most common mental disorders: anxiety and depression (Bennet, 1970; Reacher et al., 2004; Tapsell and Tunstall, 2006). Reacher et al. (2004) found adults to have a four-fold higher risk of psychological distress in flooded households compared with non-flooded. The autumn 2000 flooding in Lewes in UK was shown to be highly associated with Common Mental Disorders 10 months after the flood event, and there was a strong indication that displacement was an important factor in this psychological distress, in addition to loss and damage to property and possessions and financial concerns. Tunstall et al. (2006) also report significantly higher rates of psychological impairment among those who have been flooded compared with those not flooded but at risk.

Post-flood disruption to life has been reported as the most significant stressor from flooding affecting people's health (Tapsell and Tunstall, 2001; Tunstall et al., 2006). The aftermath of flooding, the disruption and long recovery process, appear to generate the most severe stress, with people's lives being 'put on hold' until the home is back in order. Krause (1987) suggests that the failure to consider the temporal dimensions of the stress process may be partially responsible for the disappointing empirical findings from research on stress andhealth.

Evidence about suicides in relation to flooding is very limited. One US analysis that was initially interpreted as showing evidence for increased suicides in the 4 years after natural disasters (101) was subsequently retracted, with the conclusion that 'the new results do not support the hypothesis that suicide rates increase. A paper from China reports that suicide rates in the Yangtze Basin, an area affected by periodic flooding, are 40 percent higher than in the rest of the country, but there is no direct epidemiologic evidence to suggest that the difference is attributable to flooding.

Flooding is one of the most widespread climatic hazards that poses multiple risks to human health. more people are likely to be at risk in the future which makes the systematic examination of the impact of floods on human health more urgent. Some flood victims attribute physical symptoms and ill health to the flood experience, as well as suffering considerable psychological trauma. Although the physical health effects resulting from floods appear to be relatively short lived, the psychological impact may be long lasting. A complex set of social and other factors appear to be involved in the susceptibility of people to the health and stress effects of flooding. There is some evidence in that the way the aftermath of flooding is handled by community and professional agencies, for example, those responsible for flood warning, evacuation and guidance can have a significant impact on mental health outcomes. Improving the services available to flood victims at the time of a flood event and in the recovery period may be important in improving their health and thence in reducing the burden on medical services.

Social psychological dimensions of flood risk management

Floods are the most frequently reported and costly natural disasters world-wide. The extent of flooding, and the accompanying impacts, are expected to increase over the next 50–100 years owing to the effects of global warming (IPCC, 2007; Stern and HM Treasury, 2007) and factors such as disparities in wealth and access to resources (Evans et al., 2004). Regional changes to flood distribution may mean that areas not previously affected by flooding may become newly afflicted as a result of climate change (Few, 2006). However, over the years and particularly in developed countries, people have come to expect to be protected from flooding and have become less aware of the potential risks and likely health impacts of living within a floodplain.

Flood events can have a varying and significant impacts upon those who are exposed to them as well as those who have to respond to such events. Apart from loss of life and serious injury, flood events may also impact upon aspects of human health and well being and upon social relations, as well as causing extensive damage to properties, infrastructure and the natural environment. IN the past, the intangible social psychological aspects of flooding were ignored both in policy terms and in practice (Tapsell, 2011).

Technological solutions to flood risks were emphasized and impact analysis tended to focus on economic and financial damage and losses. In addition, the response to hazards demonstrated a "command and control" mentality that focused on clean upo and the rescue of survivors. However recent years have seen an incarcerated recognition of the social aspects of flooding and in particular flood impacts upon people as receptors (Pitt, 2008).

With the growing emphasis on flood risk management strategies, there is a increasing recognition by policy makers and managers of the need to include more consideration of the socio psychological aspects of flood. This inclusion of socio-psychological dimensions in the policy and practice is essential with the move to more non structural approaches to managing flood risk particularly hose that require specific behavioral responses from the public and other stakeholders.

Tapsell (2011) develops a framework for analyzing socio-psychological dimensions to FRM (Flood risk management). The framework is based on the hazard and disaster management cycle often cited in the disaster management literature. Risk management deals with the preconditions, causes and impacts of hazards. Its multiple tasks need to be implemented before, during and after an emergency or disaster. Preparedness, damage control, recovery and mitigation are crucial aims of risk managers. The disaster management cycle thus divides disaster events into various stages: before, during and after, or pre-onset, onset and post-onset phases. Four phases are presented in this framework:

1. preparedness
2. emergency response
3. recovery
4. mitigation

This temporal aspect of the cycle is important even if flood impacts and response are dynamic and may often be overlapping or present during more then one phase. Although being useful as an analytical tool, the disaster management cycle has been criticized for portraying disaster response in a circular fashion which is said to reinforce the perception of disasters as an aberration from normal conditions and that conditions will return to normal once the event has passed (Few, 2007). This assumes that certain conditions such as social vulnerability are note preexisting in normal circumstances within affected societies which is rarely the case. In reality pre flood conditions such as poverty and vulnerability may be simple recreating following flooding. The disaster cycle also fails to acknowledge that in certain circumstances and particularly in conditions of poverty losses may lead to increased vulnerability making people more susceptible to future flooding. White et al. (2004) refer to this as a negative downward spiral. But he also promote the concept of virtuous spiral of risk reduction whereby lessons can be learned from a disaster that may result in positive adaptation and outcomes.

Preparation and planning

It is generally acknowledged that preparation and planning for natural hazards can help to avoid or reduce damage and losses and thus lessen many negative socio-psychological impacts. There are many ways in which people can prepare and plan for floods. Key factors are: flood experience (often related to length of residence in an area), awareness and acceptance of the risk and a desire and ability to take mitigation actions. Awareness is often related to paste experience of flooding. It is particularly difficult to raise awareness where no history of flooding exists and this has implications for areas with a low probability of flooding but where the potential consequences could be high. Tenure has been shown to be a factor in risk awareness in the UK (Tunstal et al., 2006): homeowners in particular may seek out information on flood risk as the home represents a significant financial investment. Renters are oftner unaware of such risk.

There is often a tendency for people to deny personal flood risk. Although many perceive their local area to be generally at risk, people do not necessarily translate that risk to their own property. All of those perceptions and behaviors are related to people's social constructions and evaluation of the risk. Renn (2008) also highlights the closeness in the connection between knowledge and values; the stage at which risk is framed and defined will inevitably involve social values in determining what risks are socially significant and the setting of goals. The information deficit model widely used by flood risk managers in the past is sais to neglect the socially embedded and contextualized manner in which people make sense of the worlds. Risks need to be viewed in the contest of evaluations of local life and local environment. People must also be motivated to take preventive actions. There is therefore a need to increase awareness not just of the probability of floods but also of the negative consequences upon households and communities, including the length of the recovery process.

Flooding is said to undermine perceptions of home, individual sense of self and place identity (Tapsell and Tunstall, 2008). People have a strong emotional attachment to their homes, can experience severe distress when they are damaged, and have reported feeling less attached to their homes as a consequence of flooding. Previous flood experience and the impact on people's identity has thus been shown to be more significant in preparing for flood than simply awareness (Tapsell, 2011).

Preparedness actions taken by households and businesses can range from keeping alert for flood warnings during high-risk months, not keeping irreplaceable items on ground floors and acquiring sandbags, to moving valuables, personal property and cars to safety. However Harries (2008) argues that one reason why people do not prepare for flooding is because such measures are perceived as endangering other needs that are more immediate and pressing such as protecting their idea of security (the home as a safe place) which may result in denial of being at risk. For others, flood mitigation measures such as flood gates were rejected as they lessen the visual conformity of their homes to an idealized norm and are often perceived to reduce the value of properties by alerting potential buyers to the flood risk. Signing up to receive flood warnings is one action that people can take to be prepared for flooding. Multimedia flood warning dissemination systems now enable more people to be contacted and also allow people more choice in the various media via which warning can be received.

Institutional measures in the form of emergency plans for flooding, provision of evacuation centers and temporary flood defenses are other measures of preparedness along with business continuity and contingency plans. Still many organizations and business do not prepare such planes. Flood maps may be one way of raising awareness of flood risk.

Response and relief

Many factors influence response and damage control during flood events. Those living in a single-storey properties may lose their entire home contents and suffer damage to every room, while for those in multi-storey properties damage is generally confined to ground and lower ground living space. However having the main living areas flooded, particularly kitchens creates huge disruption and distress. The receipt of adequate warnings and timely support can often reduce potential flood losses and distress particularly for people who are unable to move heavy belongings (Tapsell, 2011).

Even if effective warning systems are in place there is still uncertainty over if and how recipients will respond upon receipt of a warning. Research has shown a preference for face-to-face warnings for instance from flood wardens and door knocking. Actions taken by recipients are often ineffective, for example, many people try to prevent flood waters from entering properties, which reduces time that could be spent saving belongings. Flood warnings lead time is also important in determining what actions people can take to reduce impacts. Telephone warning systems work best for slow rising floods but may not be appropriate for rapid floods. Flood warning methods should be tailored according to the type of flood and to recipient and location characteristics. According to Tapsell (2011), crucially they need to be focused on facilitating effective responses during floods rather than focusing solely on warning large numbers of people.

According to Baxter et al (2001), coastal flooding has the potential to pose greater risk to life than river flooding. Several methods have been developed as means to calculate this potential risk to life in both quantitative and qualitative terms (Priest et al., 2007). Mortality associated with flood depends not only on flood characteristics (depth, velocity and speed of onset) but also on the way people respond to floods. Deaths are strongly related to risk taking behavior, particularly among males (Jonkman and Vrijling, 2008). A high percentage of deaths are vehicle-related. This highlights the importance of flood risk education. Evacuation before floods can reduce risk to life in the case of severe flooding and is frequently necessary post-flooding as properties will often be uninhabitable for many months. However, poorly organized and managed emergency response and evacuation can add to the distress to those who are flooded.

Recovery after flood

Recovery following flood is dependent upon a number of factors, key to which are the extent of damages and losses, and individual, household and community resources available to deal with these.

The extent of damages will usually determine the length of displacement and disruption to life. Where damage is extensive many people have to live in temporary housing such as hotels, mobile homes and rented accommodations for many months and lengths of up to a year are not uncommon. Such displacement can have significant socio-psychological impacts. Psychological distress is often more reflective of the difficulties and hardships encountered during recovery than the impact phase of an event. Moving back to properties before they are adequately dried and aired can cause further distress.

Disruption to critical infrastructure and services (e.g. water supply) following flooding and poor provision of logistical support can result in additional distress for those affected and also of those not flooded including increasing the risk o public health. Loss of livelihood following flooding can be particularly distressing for those affected where social welfare or social networks are weak. Taking time off work to deal with recovery can lead to loss of wages and significant financial concerns for hose on low incomes.

During and following disasters individuals and communities may respond to the threat by mobilizing personal and social resources. An individual's capacity to come to terms with a traumatic experience is greatly influenced by his or her social context. Secure, supportive relationships are essential for people's communication and processing of the traumatic experience and eventual recovery. Protection can be afforded by social resources such as received and perceived social support and levels of social capital. Social capital describes the pattern and connections of social networks among individuals and the shared values that arise from those networks. This suggests that psychosocial resources should be targets a those marginalized households who often have less access to information, support and communication channels. Psychological first aid has also been reported as one method effective in aiding recovery (Pietrantoni, Prati e Palestini, 2008).

Disaster events and the recovery process can be considered as social and communal phenomena, not just affecting individuals. Floods can impair the quality of community life due the disruption of community activities and a sense of community breakdowns . However floods can also result in a positive sense of communities pulling together and helping each other enable mutual practical and emotional support. Restoring the social fabric of communities is therefore important in responding effectively to the psychosocial and mental health effects of disasters.

Mitigation before and after

A number of factors affecting socio-psychological dimensions of flood management and risk mitigation can be identified during the period following flooding and possibly influencing future preparedness (Tapsell, 2011).

The maintenance of high levels of anxiety following flooding may influence whether people take actions to mitigate the risk of future events. Loss of trust and confidence in local authorities has been linked to the belief that flooding of properties was not a "natural" occurrence but due to bad flood management and inappropriate development rather than to climatic or weather conditions. The public often differ from flood risk managers in their views on the cause of flooding. Lack of trust in responsible authorities can impact upon how people engage with risk information they receive from these sources.

Evidence from some European countries has shown that those living and working in at-risk areas often place faith in structural flood defences and show a distinct preference for structural mitigation measures. This can result in a false sense of security and a failure of people to act to protect themselves and their properties (De Marchi et al., 2007). Lack of awareness of the causes of floods, denial of risk, protection of emotional security, fear or reduced property prices may all be factors influencing the personal responsibility for FRM demonstrated by individuals and communities.

More reliable and less stigmatizing ways need to be found by which people can increase the resilience and protection of homes without threatening their social identity.

Harries (2008) suggests three approaches:

1. Provide tailored, independent advice to property owners
2. Normalization of particular mitigation measures
3. Normalization of the notions of flood risk mitigation and of proactive response

GROUND TESTING THE INFORMATIONAL NEEDS AND INFORMATION RELEVANCE INTERMS OF POST CRISIS MANAGEMENT

A survey in the Italian study site will be performed. A questionnaire will be distributed to residents living in the coastal area. Specific scales and questions will investigate knowledge and subscription of alerting system, knowledge of emergency numbers and "what to do in case of crisis", behaviors during previous crisis, expectations on behaviors in an hypothetical major event/disaster preparedness and efficacy on recommended behaviors, personal characteristics (age, SES). Data collection is already started. Expected total numbers of participants will be 300 residents.

Risk communication[6]

Contextual elements

Taking stock of WT1.5 risk perception survey results

The analysis conducted in the course of WT1.5 serves as the foundational knowledge for the design of a communication scheme. The results of this analysis that are directly relevant to THESEUS can be summarized in the following fashion:

1. Risk is understood by stakeholders as the consequences of an event, the probabilistic nature of the event is only taken into account to justify "memory lapse".
2. Normative claims (see ID 1.6) are the priority framing elements when stakeholders envision risk.
3. Foresight by stakeholders is based on their (partial) recollection of the past and on the current state of technologies.
4. Evidence claims (i.e. claims pertaining to the way the risk functions) is solely or mostly based on the stakeholder personal or collective heuristic. Science has very little place in this process.

These four results are particularly critical within the context of THESEUS as in THESEUS:

1. We are preparing a DSS rooted into the Source-Pathway-Receptor-Consequence model, yet stakeholders focuses on consequences as the entry point, not sources, and in this model the probabilistic behaviour of the source is highlighted, yet stakeholder do not seem to take this probabilistic nature very well into account.
2. As a science based exercise, THESEUS faces the risk of not being explicit in terms of normative claims, yet for the stakeholders this is their first, and sometimes sole focus.
3. Foresight in THESEUS is based on the scenarizing of plausible changed futures, yet stakeholders, for the time being, do not have a ready cognitive access to these changed futures.
4. THESEUS is a robust, science based exercise, yet the practice of science is not central, to say the least, to the stakeholders individual and collective heuristic.

Considering these four elements, it is felt critical that the communication scheme that will be developed is geared at the four challenges that have been identified in the course of WT 1.5 and that are briefly presented here above.

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On devising a communication scheme dovetailed with THESEUS' DSS

These results are quite challenging within the context of THESEUS. These challenges lie at three level (A) use of the knowledge generated by THESEUS; (B) use of the technological and governance option developed within THESEUS, and (C) use of the decision support tool that is being developed by THESEUS.

When analysing the perception of risk by the interviewee one is forced to admit that there is currently very little space in these perception for science based knowledge. The knowledge used to frame risk belongs to the world of individual and collective experience. Within THESEUS there will therefore be a need to find a way to make the knowledge generation process a process that is integral to the communities' individual and collective experience. Without such an achievement, while the knowledge generated will be of high quality, this knowledge will not be able to deploy itself in society in a useful manner. One of the key elements here will lie into integrating uncertainty and robust foresight in peoples' thought processes.

What appears, from the interview conducted, is that for interviewee the essential determinant of risk management option adoption is its congruence with local values. The efficiency of the option envisioned seems to have less to do than its impact in terms of redistribution or relationship to nature. Therefore, any assessment of a technological choice or a governance option should include an analysis of the way it risks being normatively framed. This is quite challenging to achieve and will need serious consideration within THESEUS' WP4 and across all THESEUS WPs.

The decision support tool that is being developed will face both the issue of knowledge generation and technological option choice. If designed in a way that allow for constant connection with society it might be THE way to solve the difficulties associated with the determinant of risk perception that we have identified here.

Serving THESEUS as a whole while serving THESEUS' DSS

In order to serve THESEUS the communication scheme that will be designed, and tested, and that is presented here-below, will focus on THESEUS DSS. The basic idea is, through this communication scheme, to establish a dual cognitive pathway, allowing for the development of a robust cognitive meeting point between coastal risk stakeholder in the broadest sense and DSS users proxying for the THESEUS community. This cognitive meeting point must allow for an initial focus on consequences and the progressive building up to receptor, pathway and sources, must allow for a clear articulation of the probabilistic nature of the source AND a clear articulation as to why this probabilistic nature can be robustly described in spite of its relative invisibility for stakeholders. Achieving this first step will allow for the convergence of evidence claims. Then this cognitive pathway must allow for an explicitation and archiving of all normative claims associated either with the knowledge that is used or with the technological or governance options that are envisioned. This can only be achieved with a level of genuine stakeholder participation both at the DSS design step AND at the DSS use step.

WHERE DOES COMMUNICATION STANDS WITHIN RISK GOVERNANCE ?

As outlined in the first part of the present deliverable, risk communication is interacting with all phases of the risk governance cycle. It is therefore critical that in THESEUS, we clearly identify where the communicative focus should lie. Essentially, THESEUS will generate resources at the appraisal stage, at the evaluation stage, and in the early phases of the management stage through option generation. The communication scheme that we have been designing will thus focus on these stages.

FIRST LEVEL OF COMMUNICATION – INTEGRATING STAKEHOLDER HEURISTIC WITH SCIENCE BASED KNOWLEDGE.

ON RISK AS CONSEQUENCE AN CONSEQUENCE AS A COGNITIVE ENTRY POINT

Within THESEUS WT1.7, quite coherently across interviews, participants associate risk with the modified state of the receptor or the consequences of flooding and erosion. Very seldom do participant mention the probabilistic nature or flooding and erosion risk. It seems therefore safe to consider that for interviewees in the Santander, Cesenatico and Gironde areas risk equals consequences. When the probabilistic nature of flood and erosion risks is mentioned, it is only as part of an evidence claim associated with (over) exposure (see below) by living or having an economic activity on either the pathway or the receptor.

This is a quite fundamental result for THESEUS. One of initial cognitive drivers of THESEUS lies in the fact that, because of climate change, the probability density function of extreme events will be modified. At the core of THESEUS' WP5 development lies the definition Risk= probability times consequences. This means that, if one wants THESEUS' contribution to safer European coasts to deploy itself in society and policymaking, it will be of paramount importance to convey the probabilistic nature of flooding and erosion risk, through public deliberation.

The first element of the communication scheme to be designed is thus to stress the fact that while the DSS that is developed relies on the SPRC model, information exchange, aka risk communication, must in its initial step be focused on the consequences. This choice of cognitive entry point will allow a progressive reconciliation of stakeholders, i.e. future DSS users and their client/constituents, perceptions with the knowledge base that is prevailing in the course of the DSS development.

Once this entry point identified, the DSS should allow for a progressive "backward" move from Consequences to Receptor, from Receptors to Pathways, from Pathways to Sources, and from sources to their probabilistic nature. This leads to the conceptual figure below (Figure 23):

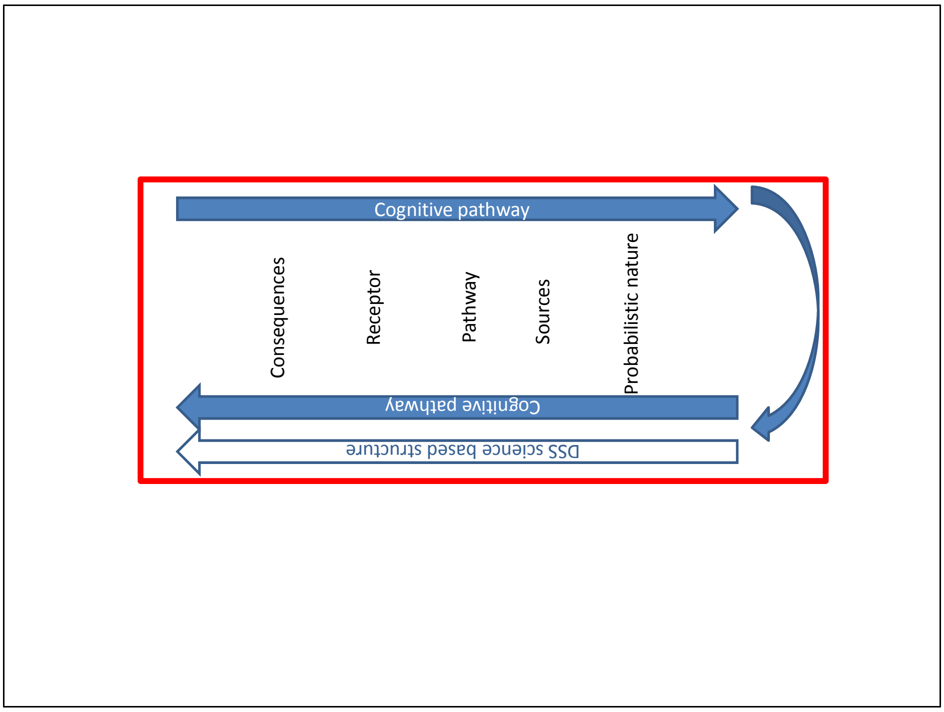


Figure 23: General structure of the risk communication scheme

Outside of the critical nature of the entry point, this cognitive pathway should allow for a merging of stakeholders heuristics with the science based conceptual model that is used, but this is allowed after the initial "backward" loop thus allowing a convergence of evidence claims (i.e., claims expressing causal linkages) .

Information gathering and exchange along the cognitive pathway

As underscored in ID1.5., risk perception are treated here through the analysis of pertinence, evidence and normative claims. It is thus therefore critical the space be provided for these claims to be expressed as part of the DSS joint discovery process. Relevance claims are claims expressing what matters to society, what are the important phenomena that should receive our attention; evidence claims are claims expressing causal linkages; normative claims are claims expressing what is good, tolerable, and/or acceptable.

In order to achieve this we propose the progressive build up of a "claim" database. When establishing the Consequences, Receptors, Pathways and Sources including their probabilistic nature space should be provided to express: (1) what are the important phenomena that should receive our attention, (2) what are the causal linkages that are expressed, (3) what is good, tolerable, and/or acceptable. This leads to the following refining of the general conceptual representation (see Figure 24 below). This means that the cognitive pathway does not only include only end users with the concerned population or as a proxy of the concerned population, but entails knowledge acquisition by the experts involved into the DSS development. This part of the communication scheme is thus leading to a co-construction of the decisions made in the course of the DSS use.

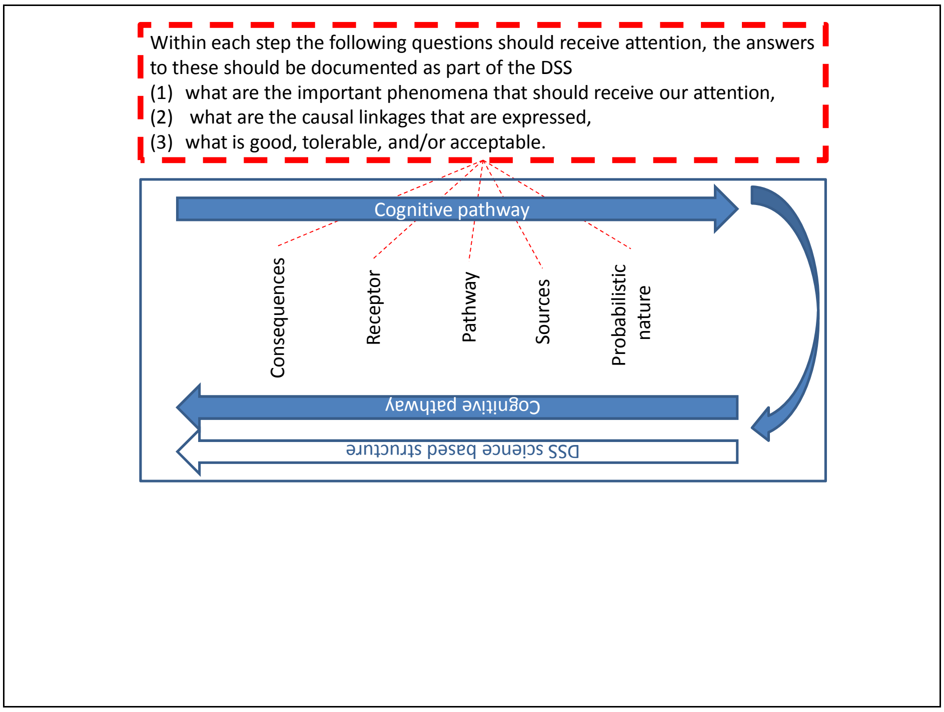


Figure 24: Cognitive pathway including the documentation of the claims that are expressed along the cognitive pathway.

It must be stressed however that interviews with stakeholders indicate that normative claims are central to risk governance for stakeholders. Very briefly said the results of the fieldwork conducted within WT 1.7 show the following line of thought. (A) Risk management is a political decision → (B) Political authorities will only move if their move is accepted by the affected population or by the affected economic agents → (C) Acceptability is contingent upon the redistributive nature of the decision to be made → (D) Coastal flooding and erosion boils down to the normed acceptability of the options envisioned → (E) In the end the risk may very well not be managed in a way that makes sense in terms of increased safety (see ID 1.5).

While the normative statement identified are essentially associated to risk management options, and are thus associated with a latter part of the present deliverable, it seems critical from the onset to allow as much space as possible. This should allow for a clearer understanding of the normative challenges associated with risk management options especially when normative statements regarding consequences enter in conflict with normative statement regarding management options.

ON THE PROBABILISTIC NATURE OF RISK AND FORESIGHT

One of the most critical results in terms of risk communication lies into the sharing of the probabilistic nature of the source. This challenge has two dimensions. First the probabilistic nature of events with relatively low occurrence is often not well understood by stakeholders. Secondly, society tends to be forgetful of events with low occurrence. Within a cognitive pathway, the sharing of the probabilistic nature of the event that is considered is thus a critical hinge point where the sharing of the stakeholders' heuristic with the scientific basis for describing probabilities must be achieved.

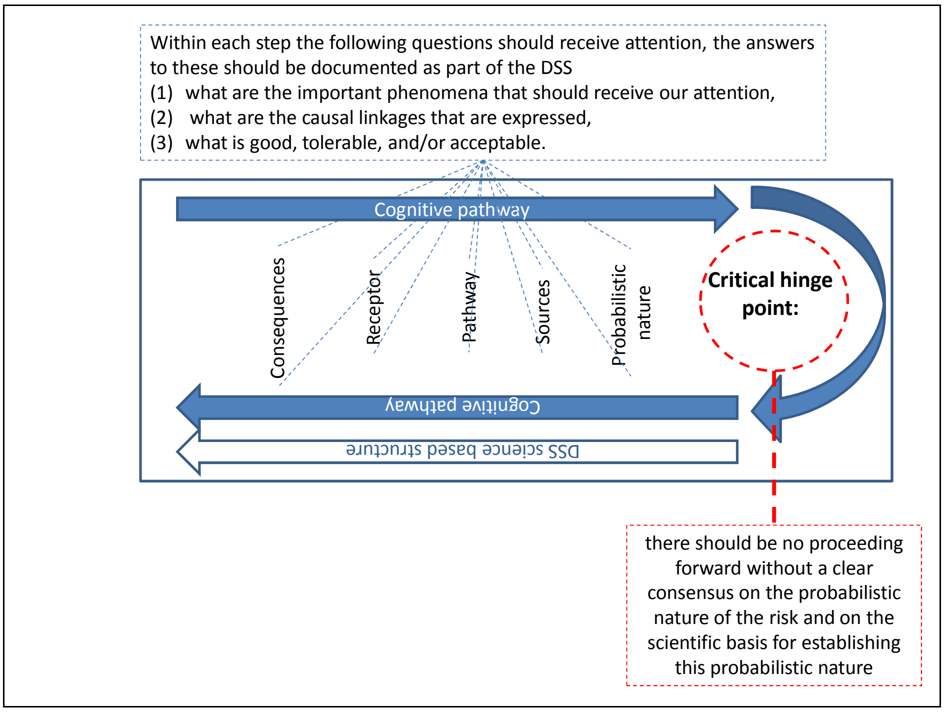


Figure 25: Cognitive pathway: a critical hinge point lies into the common understanding of the probabilistic nature of the risk that is envisioned.

SUMMARIZING ISSUES ADDRESSED IN THIS EXERCISE OF INTEGRATING STAKEHOLDER HEURISTIC WITH SCIENCE BASED KNOWLEDGE.

The contextualized, through the expression of claims, cognitive pathway has the purpose of addressing the following challenges in terms of risk perception:

1. For stakeholders the concept of risk mostly limit itself to the consequences of an adverse event;

2. For stakeholders the cognitive chain is C-R-P-S while the causal chain underlying the DSS is S-P-R-C

3. For stakeholders the probabilistic nature of the averse event is secondary to other considerations

4. For stakeholders the causal evidence embedded into the S-P-R-C model are totally secondary, their priority lies into normative claims associated with the consequences under scrutiny.

These four challenges, identified through extensive interviews with stakeholders and their analysis in the course of WT 1.7 are at the core of the stakeholders risk perception and the dissonant nature of these perceptions when compared with the scientific knowledge based generated and used in THESEUS and that forms the basis for the THESEUS DSS development.

SECOND LEVEL OF COMMUNICATION – INTEGRATING STAKEHOLDER HEURISTIC INTO THE FRAMING OF TECHNOLOGICAL AND GOVERNANCE OTPIONS.

FRAMING RISK MITIGATION OTPIONS

Once the cognitive loop that is described here above is achieved options for risk mitigation will be generated. The generation of these options will be contextualized by the various pertinence, evidence and normative claims made that should allow for an initial assessment of the choices that are possible in terms of societal acceptance. A critical dimension of the framework that is proposed lies into the identification of an indicator portfolio that makes sense for all involved. This is another element that calls of a clear expression of the stakeholders' pertinence, evidence and normative claims.

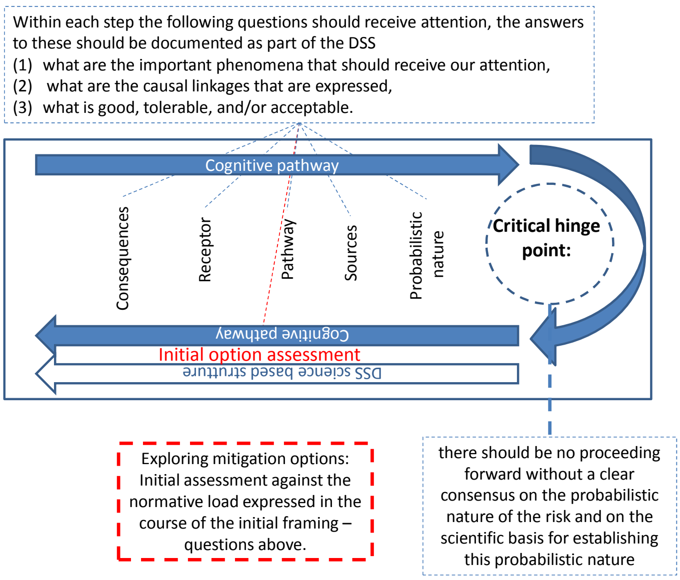
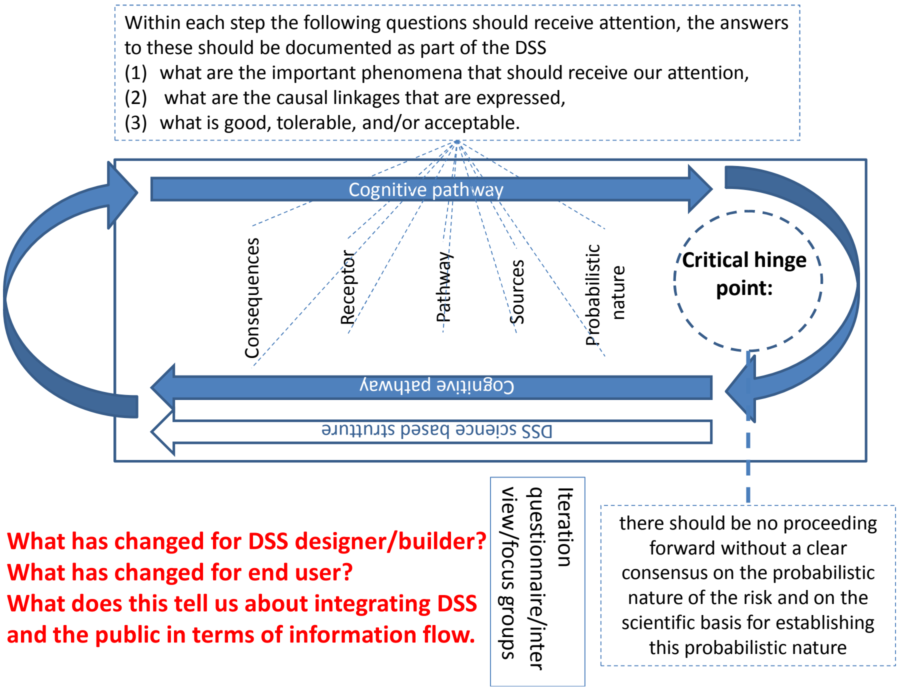


Figure 26: Cognitive pathway: Assessing mitigation option should first be assessed in the light of the stakeholders claims.

Changed perception as an output of the risk communication



What has changed for DSS designer/builder?
What has changed for end user?
What does this tell us about integrating DSS and the public in terms of information flow.

EVACUATION[7]

INTRODUCTION

EVACUATION PLANS IN THESEUS

The main objectives of Theseus project is to identify the impacts of climate change on coastal territories and to provide scenarios and options to mitigate those impacts. In work task 4.6, the "evacuation worktask", we study more specifically one of those options, at the very end of the risk management process, which is crisis management and its application to evacuation planning. The purpose of the task is to gather the best experiences from real events or exercises over the world and synthetize it in a methodology for the decision-maker to plan for a mass evacuation plan in case of flooding.

This document is the result of the work. Its main part describes a proposed methodology that can be applied to prepare an evacuation. The framework is meant to be read by decision makers at local levels who are responsible for ensuring the safety of their district, city or region.

The methodology described here was tested and applied of a pilot site of Theseus, the Gironde estuary and more precisely the city of Bordeaux which concentrates the major stakes and vulnerabilities of the estuary. It is also available in French. The data catalog in section "data collection" is available in French, Spanish, and Italian. The evacuation plan of Bordeaux is only available in French.

Finally, an evacuation software was tested in the framework of Theseus and applied on Bordeaux, Evacuation Calculator developed by the university of Twente. It has been adapted to an international context and translated in English for the needs of work task 4.6.

THE NEED FOR EVACUATION PLANS IN CRISIS MANAGEMENT

In the framework of the Theseus project (FP7 - DG Research), several research institutes and governmental organisations across Europe are carrying on technical studies for the assessment and mitigation of natural risks on the European coasts. The fourth work package of the project deals with socio-economic measures designed to reduce the impacts of hazards on the economic and social context. The overall purpose of the work package is to raise the resilience of territories. One of the components of these measures is the improvement of emergency plans: it will indeed never be possible neither to totally avoid the expansion of human activities on territories under risk nor to prevent a risk event from occurring. Thus the only remaining option is to help human societies and economic systems to be better prepared for the event.

Each year, 20 000 people across the world are reported dead or missing because of floods (Ministère de l'écologie, 2011). Flood risk is the only kind of risk which spreads over the whole planet, whether it is caused by sudden storms (flash floods), at a slower pace by a river which level raises due to abundant

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rains, or by the sea entering on the coastal zones (submersion). This number will increase in the near future because more and more people are living on territories at risk (higher vulnerability) but also because the hazard may become stronger as a consequence of climate change, especially on coastal zones. Dikes and current mitigation measures may not be enough to protect residents from the flood risk. Thus well prepared evacuation plans might be a good complementary measure against this increasing level of risk.

Assumptions and definitions

In this document, an evacuation is defined as the organisation of the movements of a large part of the population to a safe place prior to the occurrence of a natural disaster, with the aim of bringing the highest proportion of it to a safe location in a constraint time frame. In the framework of the Theseus project, the focus is given to flood events on coastal zones but the methodology could also be applied to other kinds of natural events provided that the basic assumptions are fulfilled.

An evacuation plan is a book which aims to give very accurate instructions about how the authorities in charge shall deal with the evacuation process when the event is occuring. The set of instructions is tailored to one flood-prone region and holds references to local resources and stakes. The methodology for the preparation of the evacuation plan is a list of guidelines defining the studies which have to be carried out during the process of preparation of the evacuation plan. It strives to keep as generic as possible so that it can be applied in different countries with only minor adaptations.

Even with these definitions, one can distinguish different classes of evacuations:

- Mass evacuation vs. small-scale evacuation: when we are faced with the topic of evacuation, two major classes of problems are dealt with. The first one, which we call small scale evacuation, refers to the issue of making people leave a building or a closed space as fast as possible when the place is threatened, for example by a fire or by the dispersion of a toxic substance. The main problem in this case is that the exits of the building are limited and can only allow for a small flow of population to the outside. The behaviour of the population is an essential component of these micro-scale studies. This guide focusses on mass evacuation, a larger scale approach dealing with the displacement of a whole city district, sometimes with several thousands people. The number and the capacity of the exits are still an issue but now one also has to address the problems of communicating information and recommendations to the population, dealing with uncooperative residents, managing the operations of rescue services…

- Emergency vs. preventive evacuation: the time available to organize the evacuation is a key variable in the decision process. For unpredictable events (earthquake, tsunami near a coast, airborne attack of a city), the authorities may not have enough time to summon their resources. The first thing to do is to alert the population and give some basic instructions about the state of the situation and the location of safe places. Sometimes the safest reaction is to stay at home.

People are then left alone to flee from the threatened zone or to protect themselves and their family, at least until the rescue services have been able to solve the most urgent problems. On the contrary, there are situations where the disaster can be predicted. This is especially the case for flooding for which the possibility of the event is foreseen one day before its occurrence, even if most of the time the forecasts hold a lot of uncertainties and errors. The information is nonetheless very important because it allows the authorities to think about the situation and its distinctiveness and to help the citizens evacuate. Since this methodology mainly deals with flooding, we assume that the evacuation is prepared and that the authorities are alerted 24 hours before the event.

- Evacuation to shelters vs. evacuation to safe havens vs. in-place sheltering: according to Kolen et al. (2010), several types of evacuations can be distinguished under the previous assumptions. Shelters are high and strong buildings inside the exposed area which may accomodate some evacuees and provide them with primary goods necessary for a living. Safe havens are places outside the exposed area, for example elevated and dry spots. Finally in-place sheltering is an individual preparation to the event with people moving to upper levels of their own buildings. An evacuation strategy is a combination of all these types of evacuations so they will all be considered in the methodology.

When a disaster is foreseen, the most urgent need is to evacuate people, who represent the higher-priority vulnerability of a town. Mass evacuation plans in this methodology therefore refer only to human evacuation. In some cases, a decision maker may also want to evacuate animals (pets and cattles) as well as goods if they have a high value, but this process is not tackled by the methodology since it requires even more specific transportation vehicles, a thorough knowledge of the secondary threats involved by the evacuation, and would call up a large part of the human resources of the city. For private owners whose incomes rely on animals or materials, if they still want to evacuate those sources of incomes, they have to prepare their own evacuation plans.

Lastly, the recommandations of the present guide apply mainly to evacuations in highly-urbanized places. When a disaster occurs on small villages or burgs, with a rather small extent, and is predicted soon enough, the problems are not the same: one does not have to care about road traffic for people have more than enough time to leave their homes and the authorities usually have enough resources to manage the crisis. The problem then shifts from a resource allocation problem to a communication-only matter. This does not mean that evacuation plans are not needed any longer but those kinds of plans should focus on the warning phase so that every residents are aware of the coming disaster soon enough.

MAIN CHARACTERISTICS AND ISSUES OF AN EVACUATION

LESSONS LEARNED FROM HISTORICAL EVENTS

Some return of experience has been carried out on existing disasters that required a mass evacuation. The conclusions of these observations are quite close to the previous recommendations following the Wardekker approach. Two events will be analyzed in details:

1. the Katrina hurricane, an event which was forecast two days before it actually occurred and which was one of the most catastrophic one the USA were faced with in their history ;
2. the Mississauga train accident, an industrial risk impossible to forecast but which consequences only slowly spread on the city, thus allowing for a prepared evacuation (but not exactly a preventive one).

Hurricane Katrina (USA)

Everyone now has in mind the devasting consequences of hurricane Katrina which struck the Southeastern coast of the United States on August 29th, 2005. This was the most destructive natural disaster in the country history with an estimated damage to property of 96 billion dollars representing 300 000 destroyed homes and between 1330 (Fragos Townsend, 2006) and 1800 (Litman, 2006) human casualties depending on the source of the data. After the event, the White House did a thorough and most useful job of retrieving information about how the event was managed and what were the best and worst practices (Fragos Townsend, 2006).

No later than August, 27th, at the announcement of a strengthening of the hurricane and 48 hours before the second landfall, Louisiana and Mississippi states launched the evacuation of the threatened areas following the newly-updated Louisiana emergency evacuation plan.

The plan involved public communications, staging of assets. State law officers were deployed along the routes to assist evacuation operations. Officials already knew then than tens of thousands of inhabitants would not evacuate, either because they were unable to do so, or because they were not willing to leave their home. A large number of residents also depended on relatives, neighbours or public help because they did not own a vehicle. This was espacially true in New Orléans which is one of the poorest metropolitan areas in the country. Thus 120 000 inhabitants did not own any private vehicle, which represented about 40% of the total population of the town. At this stage the authorities in charge did not make any provision for homeless, dependent, sick, old or infirm residents.

At the same time, Christian clergy was involved in the process. On the following Sunday, the evacuation order was issued in churches all over the threatened zone. Some individual initiatives were taken in Louisiane, such as the “Operation Brother’s keeper” designed to help evacuate people without any transportation mean. However only four congregations took part in it during the event.

Voluntary and mandatory evacuations started the very same day when the first orders were issued by local authorities. Residents of low-lying lands and mobile homes were urged to leave the place whereas others were faced with the difficult choice of fleeing and putting their lives in danger on the roads or not moving at all. For people staying at home, the mayor gave some advices to stock up bottled water, batteries and non-perishable food. During the same day, an information center was opened to direct people to shelters. The American Red cross welcomed people in schools and churches across the state. Four shelters were also opened for people with special needs, which were defined as "individuals with no other resources and who need assistance that can not be guaranteed in a regular shelter, i.e. medication that requires refrigeration, oxygen equipment, etc." but not individuals who need substantial or constant medical care.

At this stage, the main problem the authorities were faced with was transportation (Litman, 2006). 2 000 public vehicles were required to transport all the people not available to move on their own, but only 500 were available. Furthermore, one could have made use of private vehicles from bus companies or public service vehicles but they were no use without any driver. Most of them indeed were concerned about the fate of their families and went back home. In the future, emergency drivers should be called and assigned a mission right at the time it is known that the event will occur. On the roads, individual drivers had to deal with other problems: since fuel stations were not supplied any longer, there was a fuel shortage. Moreover traffic jams totally blocked the traffic on some roads and many drivers, after having waited for 9 hours in their car, decided to go back. One of the things that was a success was the police barriers to prevent cars from driving back to the exposed zone.

During the two following days, an emergency agency was established and personel, supplies and resources were pre-positioned across the territory. FEMA's regional headquarters were activated with full staffing round the clock and seven-days-a-week, in accordance with the highest alert level procedures. All emergency support functions were activated as well on this day. Warnings were issued on a regular basis through the radio, the television and the Internet.

When the hurricane stroke, the damages proved to be as important as foreseen. Many cities were decimated. But what has to be remembered is that many of the key infrastructure for evacuation implementation were destroyed. For instance, the I10 interstate was closed to the public. In some cities, communications infrastructures were reported as non existent any longer. Katrina incapacitated telephone service, police and fire dispatch centers, emergency radio systems, and many television stations. The New Orléans mayor's office operated from a nearby hotel but was unable to establish any communication outside the city for nearly 48 hours. These successive failures stress out the need for redundant infrastructures for communication and sheltering during an evacuation because the event itself may damage the existing ones. Furthermore information is a key factor for an efficient crisis management and one of the lessons reported by the White House manual is the establishment of a monitoring and communication system for the quick gathering of environmental data and its communication to the public.

After the event, there was still need for further evacuation and relocation. The stadium in New Orléans accomodated people by thousands but a power shortage made officials feel concerned about the fate of the 20 000 persons in it, all the more so that it started to become really difficult to manage re-supply and flood protection operations. This led to another relocation of the people in it in the following days, which emphasizes the need for a strong policy for assisting peoples in shelters in post-evacuation phase. Meanwhile authorities in the exposed regions noticed that a subsequent number of people took up shelters in places not prepared for this, only because they were large public buildings on dry sectors. This led to additional problems with refugees not having anything to eat and drink. Preparedness and information of the population is thus a vital element of a good evacuation.

Law enforcement in devastated areas appeared to be a real problem after Katrina. The authorities were too busy with the protection of the population and could not respond the calls for help and to combat lawlessness. Therefore the rate of crimes increased and grew worse with every passing day. A recommendation was formulated after the event to integrate operational plans in the emergency management plans to ensure an effective law enforcement response.

Communication appeared to be a major issue during the event. The department of Defense deployed every available communication assets it owned in the affected areas in order to supplement the usual networks. Nevertheless this rose also other problems of interoperability. Thus, the establishment of a crisis communication infrastructure which can interoperate with common systems is a vital need.

For evacuated people in shelters, assistance is still needed during the whole event. 250 000 people relied on shipments of ice, food, water, fuel to power the generators, medicines and medical people to help. This led to a recommendation of stockpiling first-need resources at strategic places all over the exposed region. This purpose may be reached by subcontracting with private companies if the public sector can not meet the needs of the population for a large amount of time.

One of the main reproach addressed to the public authorities after the event was a lack of accurate and coherent communication to the public. An integrated system to deliver assistance to people should be established as a central office so that everyone can get an oriented and effective response and know how one can access information and advices.

Finally, non governmental organizations and individual communities proved to build up automatically in times of crisis. With lots of citizens and sometimes a well-prepared emergency plan and trained participants, they can provide extraordinary services. The government has to use these services as well as possible, by designing prior to the event a seamless coordination plan between operational rescue services and volunteer organizations.

Mississauga (Canada)

Mississauga is a the name of a city in the South of Canada, which can be remembered as an example of a successfully implemented evacuation plan. On November, 10th 1979, a train with toxical compounds went off its rails and the chlorine cloud which escaped threatened the whole population of the city.

Crisis headquarters were activated a few minutes after the event and decided to evacuate the city. In 24 days, the authorities managed to make 260 000 inhabitants leave the city, a record for an unforeseen event such as this one.

The authorities chose to evacuate the city in a progressive way, starting with the most exposed inhabitants. This decision proved to be really good because it diluted the traffic which remained rather fluid. Hospitals were evacuated at strategic moments. A circulation plan was established in the densest places, and modified priorities at the intersections and traffic lights.

Most of the evacuated people went to relatives or friends. Only 5% had to rally public shelters, which were operated by volunteers. This shows the importance of an early collaboration with volunteers organizations. The whole evacuation was perceived as efficient, and this thanks to an excellent communication. Early messages and advices convinced people to flee from their homes in a quiet way. Amateurs radios allowed people to know the fate of their relatives who were in another shelter. The crisis headquarters gave regular updates on the situation of the train, thus creating a trust relationship between authorities and citizens. Once more, these observations stress out the need for a continuous information of the population about the state of the event.

Summary of issues to be solved

As can be seen in real examples, a mass evacuation of the population of a town is a complex process which spreads over time and space. Most of the scientific work in this field is aimed at the numerical simulation of the displacement out of the exposed zone through the road network. This topic, as challenging as it may be in a mathematical and algorithmic point of view, is only a small part of the whole process. The whole frame can be described as successive steps (Morel, 2011) (see Figure 27 below) :

1. continuous watchfulness during times of the year when a disaster may occur ;
2. decision of evacuating when a threshold of hazard level is reached ;
3. alert of the population and transmission of advices ;
4. preparation of the evacuation by the authorities and the inhabitants at the same time ;
5. implementation of the evacuation, people moving to safe places and shelters ;
6. management of the post-evacuation during the crisis ;
7. after the end of the event, return to a normal situation.

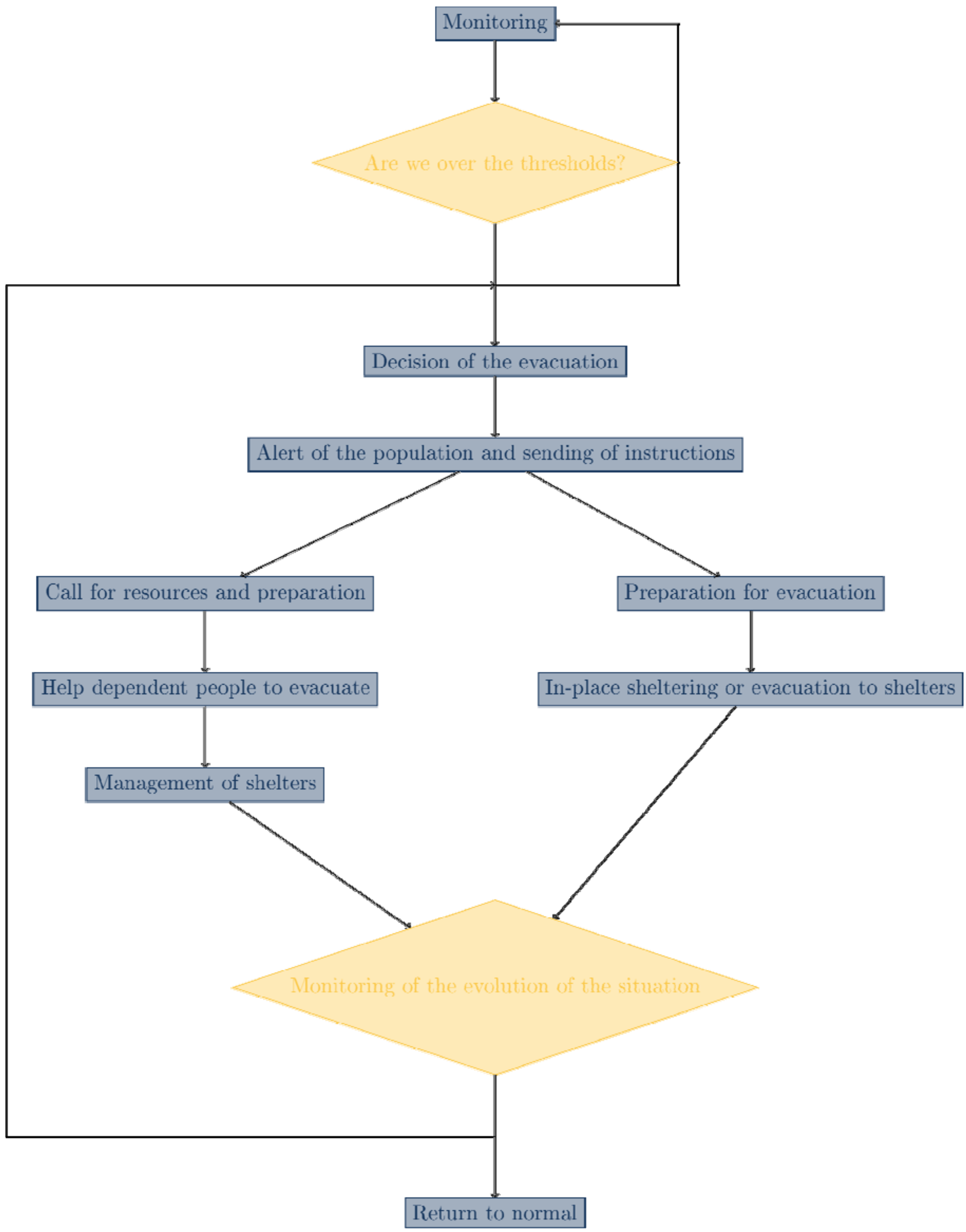


Figure 27: The successive steps of an evacuation process

During the event, the actual situation of the territory is monitored and a new evacuation phase can be launched with more resources or to other places further from the exposed zone.

In order for an evacuation to be considered as successful, ten major issues have been identified and should be solved during the stage of preparation of the actions plans:

1. know and anticipate the hazard in an uncertain environment;
2. define and implement efficient strategies by activating so-called “levers of actions” and make sure that all necessary actions are taken in the required delays;
3. make sure all required financial, human and material resources are available at the time of the evacuation;
4. coordinate the actions of different role players and decision makers involved in the emergency management (state institutions, local elected representatives, army,…)
5. integrate human, political and technical considerations in all the stages of the decision process;

This first group of topics has to be dealt with before the actual event, during the preparation stage. The following ones must be considered later when the evacuation decision has been taken:

1. organize the alert of the population beforehand and try to convince most of the inhabitants to go out of the exposed zone;
2. anticipate unpredictable events and be able to manage them. These events indeed tend to happen quite a lot during a crisis, with chain reactions worsening the already serious disaster: power shortage, traffic jams because of too many people trying to flee from the city at the same time, panic,…;
3. control the flow of people and goods during horizontal evacuation in order to avoid traffic jam and accidents;
4. assist dependent people (prisonners, patients in hospitals, old and sick people, pupils…);
5. manage the post-evacuation stage: ensure safety in evacuated zones, assist people in the shelters.

STATE OF THE ART IN EVACUATION PREPARATION

METHODOLOGICAL WORK

Some methodological work has been carried out in the past few years regarding evacuation preparation. Only few scientific articles however deal with the full process of evacuation whereas many focus on some aspects of evacuation planning, like the evacuation of a building or traffic management. Most of the reference guidelines were written by governmental authorities.

In Canada

Among the most up to date documents, we may list the strategic guidelines for the planning of evacuation operations in high density urban zones, from the Canadian government (Beaulieu et Marchand, 2001). This document gives an overview of the whole process of evacuation: the regulatory context, the people involved and their role in emergency management, and a thorough description of the successive stages of planning and decision making, from the identification of the system at risk to the evaluation of the strategy. It also gives a number of guidelines for each organism involved.

The report starts by identifying some planning variables, indicators which have to be taken into account in order to decide the launch of an evacuation and how to run it. Since many sectors are impacted by the decision, the variables not only qualify the demographic and environmental situation (population and its location, land use, identification of hazards sources) but also describe sociological aspects (language, birth, religion, age, sex, level of education), economic aspects (unemployment rate, activity rate, availability of workforce, productivity of firms), psychological conditions (psychological health of population, fear, anger, alcoholism and drug addiction), and the financial abilities of the community in charge of the evacuation managing. The document strongly advises to provide values for all these indicators to shed light on the emergency management process and help the decision maker in its task.

According to the recommendations, every public and private service related to the threatened territory or which owns resources useful for the emergency management has a role to play in the evacuation and therefore should be included in the planning process. As first authorities involved in emergency management, and usually responsible for the leading of the operations, municipalities have to organize themselves so as to be prepared in case an event occurs. Urban planning authorities can feed them with accurate data about land use, distribution of the population, location of the buildings and equipments. During the evacuation process, the police is responsible for traffic management and law enforcement in evacuated places. Fire brigades will also be asked to help disseminate instructions to population, help dependent people leave the area and protect sensitive places. Road-traffic management services have to monitor traffic and communicate information about advised routes to drivers. Public transportation companies have to adapt their services to help the transportation of dependent people. Ambulances services should also be involved in the particular task of evacuating disabled persons or people who need special medical cares. Schools must be consulted at two levels: when they are located in the threatened zone, they should take measures to protect the pupils or to bring same to safe places; when outside the threatened zone, they should on the contrary be organized to act as shelters and to welcome evacuees. In the same manner, some charitable organizations can come to the authorities' assistance and accomodate evacuees. Public authorities at higher level (ministries of environment, transport, communications, agriculture) will also play a role, by providing local services with information and data they need, by coordinating the actions of several services under their responsibility, or by analyzing the main hazards – direct or indirect – and the way to mitigate them. Finally, a good evacuation plan should also involve volunteer organizations and NGOs which can supplement the operations of public services, in particular to improve the comfort of evacuees or provide them with medical and social care. The last role-player in emergency management is of course the evacuee himself who should not have a passive and wait-and-see behaviour: the picture of a scared individual with irrational behaviour is a myth; nowadays the citizen is not only the beneficiary of the emergency measures but also an active player with a great potential to act towards a better management of the evacuation.

Then, for each of those role-players, the report enumerates a list of tasks to be carried out in three stages:

Planning:

The purpose is to describe and delineate the system at risk and to identify subsystems with high probability of disaster. At this stage one should evaluate direct risks, with a clear relation to the natural hazard, indirect risks triggered by the occurrence of the disaster on sensitive stakes, and also risks of failures in the emergency management process. The system should be described as accurately as possible, with all the stakes, equipments, buildings, materials, resources it holds and procedures or contracts which apply to it.

Decision:

The decision is based on the observation of the territory, and follows an exceedance of thresholds by monitored parameters. More knowledge about the predicted disaster can be acquired by simulations. For each disaster scenario built, an operations scenario describes the actions which have to be carried out to ensure the safety of populations. The operations scenario also have to be analyzed and tested before the crisis. The choice of an operations scenario during the crisis is based on a critical evaluation of primary and secondary risks in the particular situation at the time of the event. The accepted scenario may be adjusted with mitigation measures to reduce the secondary risks induced by the plan.

Implementation:

Once the decision to evacuate is taken and communicated to the population, the plan becomes an official list of actions which require the use of human and material resources and their coordination. The evacuation strategy should be monitored during the whole process. According to the development of the situation on the field, another stage of decision may be required.

In New-Zealand and Australia

A similar methodology was established more recently by the Australian government (Emergency management Australia, 2005) and the New Zealand government (Ministry of civil defence, 2008). Those two documents are very similar in their structures. They are focussed on giving concrete guidelines for the operational implementation of the evacuation plan during the crisis event and go through all the stages of the planning process. The two options of in-place sheltering and evacuation are clearly identified and associated with different disasters: in-place sheltering is rather to be considered for toxic chemical spill, radiation release, act of terrorism, pandemia and volcanic ashfall whereas evacuation may be chosen for riverine and flash flooding, storm surges, landslides, wildfires, tsunamis, volcanic activity, lifeline utility and infrastructure failure. But apart from this distinction, the report also describes two types of evacuation: mandatory evacuation which implementation the authorities are responsible for when the risk is thought to be too great to allow the inhabitants to stay where there are, and voluntary evacuation when people decide to leave their home because they perceive a threat even if no action was required by authorities. The report also introduces the concept of shadow evacuees.

An evacuation plan has to address at least the following issues:

- conditions under which an evacuation is necessary,
- conditions under which to support people sheltering in place,
- identified vulnerable groups,
- command, control and coordination instructions (including the names or functions of the persons in charge),
- warning instructions to be issued,
- special procedures for dependants,
- plans for public transportation, evacuation routes,
- means of accounting for evacuees,
- welfare support for evacuees,
- security of evacuated areas,
- procedures for the return of evacuees.

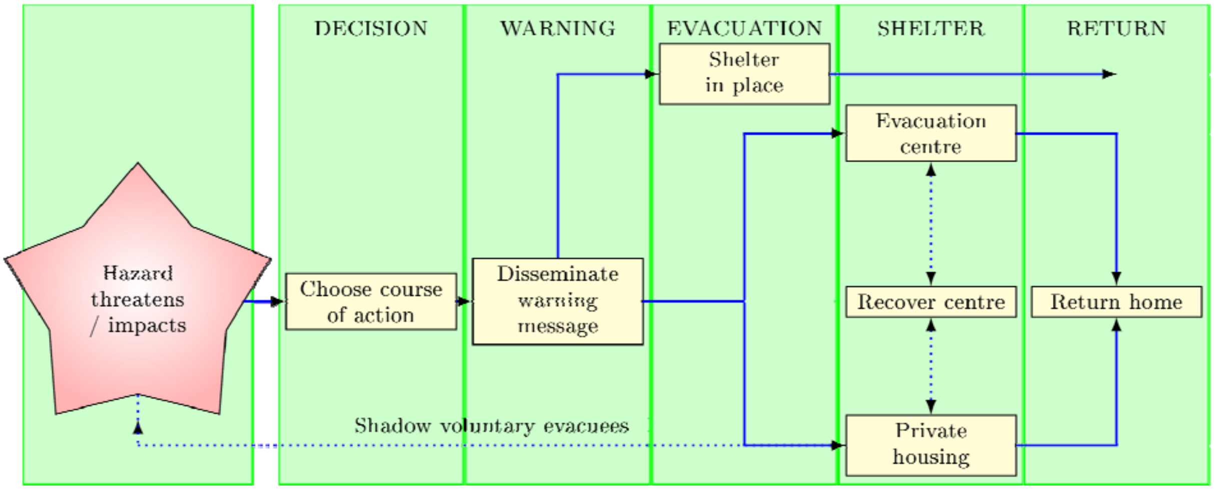


Figure 28: The five stages of the evacuation process according to Mass evacuation planning

The guide goes through all the stages of the analysis: establishment of the authority to plan, establishment and meeting of the planning team including representatives from organisms included in the evacuation process and from the stakeholders, analysis of the community and especially the demographic aspects, review and assessment of the hazards and risks, definition of the objectives of the planning with large-scale indicators of areas to be evacuated and people needing special care for example, determination of the roles and responsibilities, development of a plan and establishment of the evacuation management process, exercise and validation of the plan, addressing of the deficiencies of the plan, reviewing and repeating.

A particular focus is made on the decision-making process and the kind of sheltering that ought to be chosen. Most of the time, in-place sheltering is a better option because it is easier to implement, less expensive and less time-consuming while more likely to succeed. In-place sheltering may even be the only option left when there has been a signification disruption to transport or when the sole action of going outside exposes people to the hazard (for instance during chemical spills disasters). On the contrary, horizontal evacuation should be preferred when the risk of staying at home is higher than the risk of leaving one’s home (lack of primary needs – food and water, lack of suitable shelter or alternative accommodation, threat on the health, too great burden for caring people at home).

When the decision is taken, one has to consider the time frame of the evacuation process because this variable is critical in the evaluation of the consequences of the decision and the chances of success of the emergency management. The time frame can usually be divided in several successive stages:

- Mobilisation of resources by the authorities
- Warning: dissemination of evacuation warnings to the population

- Warning acceptance factor: the time needed for the population to accept that the warning is real
- Warning lag factor: the time needed for the population to pack and get ready to leave
- Movemement of the population outside of the threatened zone
- Traffic safety factor: additional time to allow for breakdowns and road crashes

The warning acceptance factor and warning lag factor are quite difficult to predict. They depend on the level of education of the population, the perception of the risk, memories of past disasters, information about the behavior to adapt in an emergency context…Reducing these factors can only by achieved by a strong preventive communication. On the other hand, computer simulations of traffic can help estimate the duration of the movement stage. For a fast rough estimation, one can use available data about vehicle ownership and vehicle use in emergency and consider that all the vehicles will try to evacuate through regional roads, which capacity will be about the half of the capacity in normal driving conditions.

In the United States

Regularly struck by a number of hurricanes, the United States also prepared guidelines for the planning of evacuation on their coastal territories (see US Army corps of engineers, 1995). Many US cities already prepared their own evacuation plans.

Older than the other guidelines, the document published by US army corps of engineers confirms the recommendations of the Canadian, Australian and New-Zealand governments. It encourages cities to do a thorough hazard modelling and vulnerability assessment during the preparation of the evacuation plan. The hazard can be represented usign statistical observations of past events combined with a physical modelling of the wind and storm propagation. This information allow for a generation of time-history data on previously-identified critical points selected to coincide with locations where the disaster would probably curtail the evacuation (low-lying roads, bridges, vulnerable population centers). Using this time-history data fed by numerical modelling, the study manager can estimate prelandfall hazards time and compare them with the total evacuation time, which will guide his decision. On the other hand, a full vulnerability assessment should comprise the following elements:

- the drawing of inundation maps in real time,
- data about the vulnerable population comprised of all persons residing within the area subject to storm surge and especially residents of mobile or manufactured homes,
- a definition of realistic and probable evacuation scenarios reflecting the operational intentions of local emergency management officials,

- a delineation of evacuation zones which will be a base to locate and quantify the population, to model the traffic and to determine the needed shelter capacity. Evacuation zones should be related to the expected flood limits, the natural database units (districts, municipalities…). They should be made to facilitate the communication of evacuation orders. To the extent possible, the boundaries should coincide with identifiable natural or articial geographic features. They should also be served by major roads and have relatively balanced populations.

- the identification of medical facilities that would require evacuation under various threats because of their proximity to vulnerable areas or the inundation of access routes,

- an estimation of the public transportation demand based on population data,

- an estimation of special emergency transportation needs for the elderly and infirms in private homes.

A behavorial analysis is useful to determine the way the population will react to the threat. This information is necessary for a better planning of shelters and transportation needs. The psychologigal response has been shown to vary a lot with the specific circumstances. Surveys can be a good starting point to retrieve this information but they have to be supplemented by a comparison of the results with statistics obtained from real-life disasters.

Next, a shelter analysis will help to estimate the number of spaces available in shelters and to compare it with the number of persons seeking public shelter. This analysis should address locations, capacities, demand and potential vulnerability of the shelters. It will lead to the assignment of shelters to each evacuation zone.

Finally, the transportation capacities and availabilities should also be analyzed. The purpose is to estimate the clearance times, that is the time needed to conduct a safe and timely evacuation. This study may also lead to propose traffic regulations measures. This stage can take advantage of a traffic simulation model. It usually takes as input socio-economic data, behavioral data, sheltering information, and a description of the road network, together with a pattern of trips for each vehicles, and returns the clearance time. The simulation can also help to analyze the benefits of traffic control measures.

Decision support tools

Traffic-based

Characteristics Most of the scientific staff involved in the simulation of evacuation is actually made of computer engineers. They really fancy computing the time needed to evacuate a zone based on more or less hypothetical assumptions. Indeed, this exercise requires a lot of high-level algorithms, from the computation of shortest paths from one point to another, to the optimizations of linear or non-linear high-dimensional functions under constraints, through multi-agents simulation and parallel processing of time-consuming computations. This makes the simulation of evacuation a challenging issue and ranks it in the top-ten best-liked problems.

Usually the assumptions of these models can be described as follows. The town or the region to evacuate is considered as a closed system. The network which can be used to proceed with the evacuation is given by a set of vertices and oriented edges. An edge ($Є_{AB}$) connects two vertices A and B and stands for a road or a part of a road between two crossroads. Each edge is associated with a limit speed (which may be different according to the kind of vehicle i) which is a function of the “discharge” at the same moment $V_{max,i}(Є,t) = f(Q(Є,t), Є, i)$ and a maximum level of traffic Qmax(Є). Some models are able to take into account the fact that an edge is available at one moment and flooded at another moment:

$$Q_{max,i}(Є) = \begin{cases} Q_{0} & \text{if } t < t_{0} \\ 0 & \text{if } t \geq t_{0} \end{cases}$$

A vertex is a crossroad. The inhabitants are considered equal and their location is represented by a time and space distribution over the transportation network.

More precisely, a number of vehicles is generated across the network according to an expected density of population and a departure law. This is the generation step. In some models, the number of vehicles depends on the composition of the population: age (because middle-aged adults are more likely to drive a car than children, teenagers or old people), sex (because there may be a behavioral difference between men and women), number of dependent people (sick people, children, old people…).

The departure law gives the proportion of people who have left their homes with respect to the amount of time elapsed since the first order to evacuate. The shape of this function is based on observations and assumptions about the behavior of the population. Right after the evacuation order, many people may not have heard of the order and are still staying at home. Some of them have started to prepare for the evacuation (gather most important belongings, take contact with relatives, fetch the car…) but they will need some time to actually leave their home. So at the start, the function has a very low slope. Later, the slope increases when we reach the average time needed to prepare for the evacuation, about two hours. When almost all people managed to leave, only those who do not want to flee are still in their homes. The slope is decreasing again until the final proportion reaches the expected proportion of people who will leave on their own. One can expect that, after 7 or 8 hours, everyone who really wants to go away from the exposed region will have left his home. This is called the S-curve or logistic curve. The blue curve on Figure 29 below shows an example of this departure law. According to current experience, the final proportion is bound to reach about 70% of the total population, but this figure may vary a lot across countries and regions. To get a better insight of this figure, one should survey people from the exposed region.

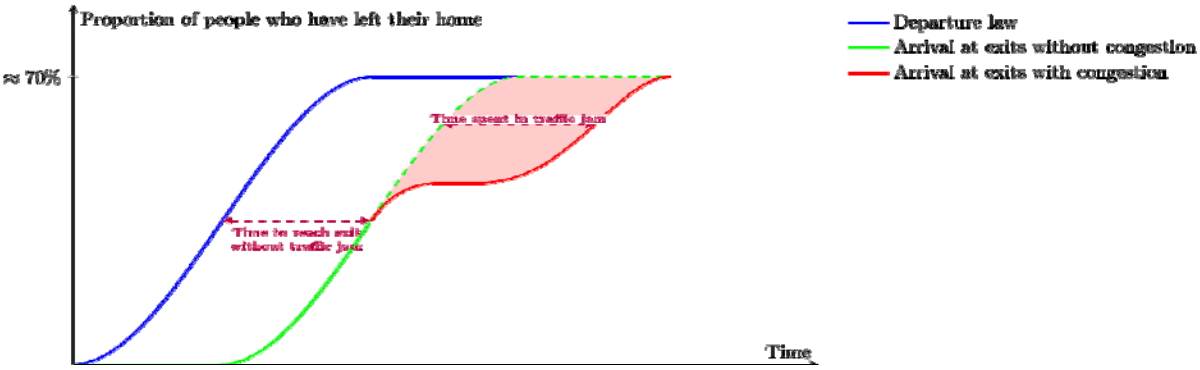


Figure 29: Example of evacuation curves

From the moment people are on the road network, they will concentrate on some main roads given their knowledge of the road network, their driving habits, the exit they try to reach. This will eventually lead to traffic jams when the real number of cars on the road is greater than the maximum discharge. The effects of those will be to lengthen the delays to reach the exit of the exposed region. People stuck in traffic jams have absolutely no way to either get out of the flood-prone zone or go back home and try to find a safer place to stay during the event. Thus their situation is dramatic and they are very likely to get severely stroken by the event. Moreover being stuck at a place without any mean to communicate with relatives and to be informed of the evolution of the event generates panic movements and makes the consequences of the flood even worse. Therefore traffic jams should be avoided as much as possible. The whole point of a well-prepared evacuation plan is to guess where those jams will occur and what measures can decrease their amplitude.

The output of every traffic-based software is the evacuation time, which is the time needed for a given proportion of the total population to reach a safe place (or to go through an exit).

Usually softwares designed to help decision makers elaborate their mass evacuation plans propose to implement several scenarios and test the consequences of measures taken by the authorities. For example :

- communicate to people and give them advices about the time they should leave their home,
- share the flow of cars on different exits based on the departure location,
- change the maximum discharge of a road by setting the two lanes on the same direction,
- decrease the number of individual cars by assigning more public vehicles to the transportation of people.
- …

At each step, softwares take into account the fact that not all citizens will respond to the advices as expected. The behaviour of the population is represented by some numbers which are based on a return of experience of past evacuations.

What makes the softwares different from one another is the scale of the traffic representation and the way the vehicles are represented in the simulation.

Scale of the models In some traffic models, each vehicle is represented along with its physical characteristics (capacity of acceleration, maximum speed…) and the behavioural characteristics of its driver (more or less polite, in a hurry). The model manages its interactions with other vehicles. They are called micro-scale models and are based on the actual road network with a generation of departures for each building in the threatened zone. These range of models are the closest to the reality of the traffic. They need only light assumptions in order to be used. A drawback is that the user has to feed them with very accurate data that is sometimes not available. The assumptions he can avoid thanks to the quality of the model are required by an only partial knowledge of the territory.

The macro-scale models use aggregated data at the scale of a district: population is generated on the whole district at one, and only the number of vehicles at the different exits are computed, not the actual path of the cars between their home district and their assigned exit. Since they are a lot of uncertainties in the way the event is occurring, or in our knowledge of the behavior of the population, or even on the actual location of people at the beginning of the event, every model has to introduce coefficients to take this into account. Finally one can hope all the model errors will compensate thus leading to an acceptable result. This kind of models require much less input than the previous one, but now the user has to propose values for many parameters which most of the time he will do quite randomly based on his own experience. To improve the simulation, one can try to calibrate the values of the unknown parameters thanks to a return of experience after a real event or a crisis exercise.

Finally, between those extremes, there are meso-scale models which do not take into account each single vehicle but deal with a number of vehicles on each edge of the road network. The traffic is then represented by flows of vehicles between the edges.

Static versus dynamic The distinction between static and dynamic models is the same as the one between static fluids and dynamic fluids. In a static model, we assume that, given a certain flow of vehicles which want to go from one point to another, the network will reach an equilibrium state where each road will be populated with an actual flow of cars depending on its capacity. The static models are mostly used by planning studies when a decision maker has to assess the impact of the building of a new road in a city. They may not be well adapted to evacuation problems for which the dynamics of the movements of the population are a critical component of the process.

On the contrary, dynamic models include one more dimension in the simulation: time. Each quantity used by the simulation is a function of time. Those models are better suited for evacuation studies.

List of models The Floodsite project (FP6) compared four evacuation planning softwares on the same town in the Netherlands (Mak, 2008, Lumbroso et al 2009). Table 12 below shows the results in terms of final evacuation time for an optimized scenario. As we can see, current models are still lacking some accuracy and their results strongly depend on the inputs and the assumptions. Only with strong return of experience on several real evacuations would it be possible to calibrate and assess them in unknown situations.

Table 12: List of evacuation models

Model name	Developer	Type	Time of evacuation
Indy	TNO, TU Delft, KU Leuven	Micro	22h
Orems	Oak Ridge laboratory	Micro	
Evacuation calculator	Rijkswaterstaat, University of Twente	Macro	12h
Escape	Zeeland, Flanders, Essex	Macro	44h
Life safety model	BC Hydro	Micro	

Evacuation calculator The software Evacuation calculator, developed by the University of Twente and financed by Rijkswaterstaat (see Mak, 2008), has been analyzed and adapted in the framework of the Theseus project. Its aim is to provide a method to calculate how much time is required for an evacuation based on different traffic management scenarios. It is now included in the Dutch flood management system. The software was designed with two aims:

1. help authorities find the bottle necks of the road network by evaluating the flows on each road during an evacuation;
2. estimate the total evacuation time needed for the population to flee the threatened zone.

The main advantage of Evacuation calculator over its competitors is its ease of use. To be run on a city or a district, the software only needs to be fed with data available at the national level: basic road network, distribution of the population over the spatial extent and social categories. The drawbacks are that some data need to be estimated with one’s common sense and experience. For a more accurate simulation, one should therefore consider either to calibrate it with the outputs of another dynamical software, or to carry out sensitivity analysis to study the impacts of a small change of the parameters on the final result. The model uses as background a static traffic model called OmniTrans.

The following input data is required to run the evacuation calculator:

- A division of the threatened region into several areas, homogeneous according to the social position of their population, their density, and with similar sizes. In the Netherlands, postcode areas are used because it is at this level that the data about population is available. For other countries, one should select a relevant area based on the availability of socio-economic data. If there is no database of social characteristics of the population, one should at least select areas as small as possible for which the total population is known.

- The identification of several exits of the threatened area. An exit is located at the border of the flooded zone and is a major road bound to be used by many vehicles when the evacuation order is issued. The exits do not have to be associated with the areas at this stage. However, the distance between each exit and each area has to be evaluated. Furthermore one has to provide the model with the capacity of the exit and its relative attractivity. The capacity depends on the type of road: motorways and wider roads have more capacities than local ways. Attractivity stands for how likely people are to choose this exit instead of another: this may depend on the event they want to flee, their knowledge of the traffic on that road in usual times…

- The average velocity at which inhabitants drive to the exit.

- Some basic knowledge about how people will respond to the evacuation order, which will be used to define the shape of the logistic curve. Two numbers are required: the amount of time after which half of the population will have left their home and the additional amount of time required for 90% of the population to leave their home.

- The total population of each area identified previously.

- The share of the population among social categories. Categories can be defined by the user and allow to define different behaviours during the evacuation process. For example, one can decide to distinguish between people over 60 because they are more likely to require assistance during evacuation. One can also choose to distinguish between healthy and sick people. There are no limit to what is possible for the software. The only thing the user has to know is the number of people in each category and the kind of vehicles they will use. For instance, healthy people will use private cars so there will be about 2 of them in every vehicle. Dependent people will use public tranportation and there will be 40 of them in each bus.

When all this data is known and put in the software, the evacuation time is automatically calculated according to four different traffic management scenarios, as shown on Figure 30 below:

- Nearest exit:
    - Every resident chooses to evacuate through the exit closest from his home area.

- Reference:
    - People in each area are shared over the exits according to their relative attractivity. Thus an exit which is twice more attractive than another will be chosen by twice as many people. However the reference case is an unrealistic scenario, since it assumes many people will drive through the whole city to reach an exit far from them although another exit was much closer. This case has been introduced to take into account cross flows, with people wanting to go back home or to reach a particular location during the flood even if it is not on their evacuation route. The documentation of Evacuation calculator states that this option was made to give an estimate of the evacuation time in a realistic scenario in which cross flows have been taken into account by artificially increasing the result.
- Traffic management:T
    - his scenario represents the best case: the authorities are able to dispatch the population flow over the exits based on their capacities. This will lead to the shortest evacuation time.
- Outflow:
    - With this scenario, the user is given the possibility to associate areas with exits, as if authorities were issuing orders or advices about the paths people have to choose during the evacuation.

By comparing the outputs of the model, the decision maker is able to choose the best evacuation strategy and to fine-tune it according to his own knowledge and experience.

However, using a model like Evacuation calculator to calculate the time needed for the population to evacuate, one has to keep in mind that the results are based on strong assumptions about the way people the evacuation actually occurs which may differ a lot accross countries. Moreover, no result is more accurate than the original factors. Thus, this tool should only be used for comparison between different strategies, or for a rough calculation of the evacuation time.

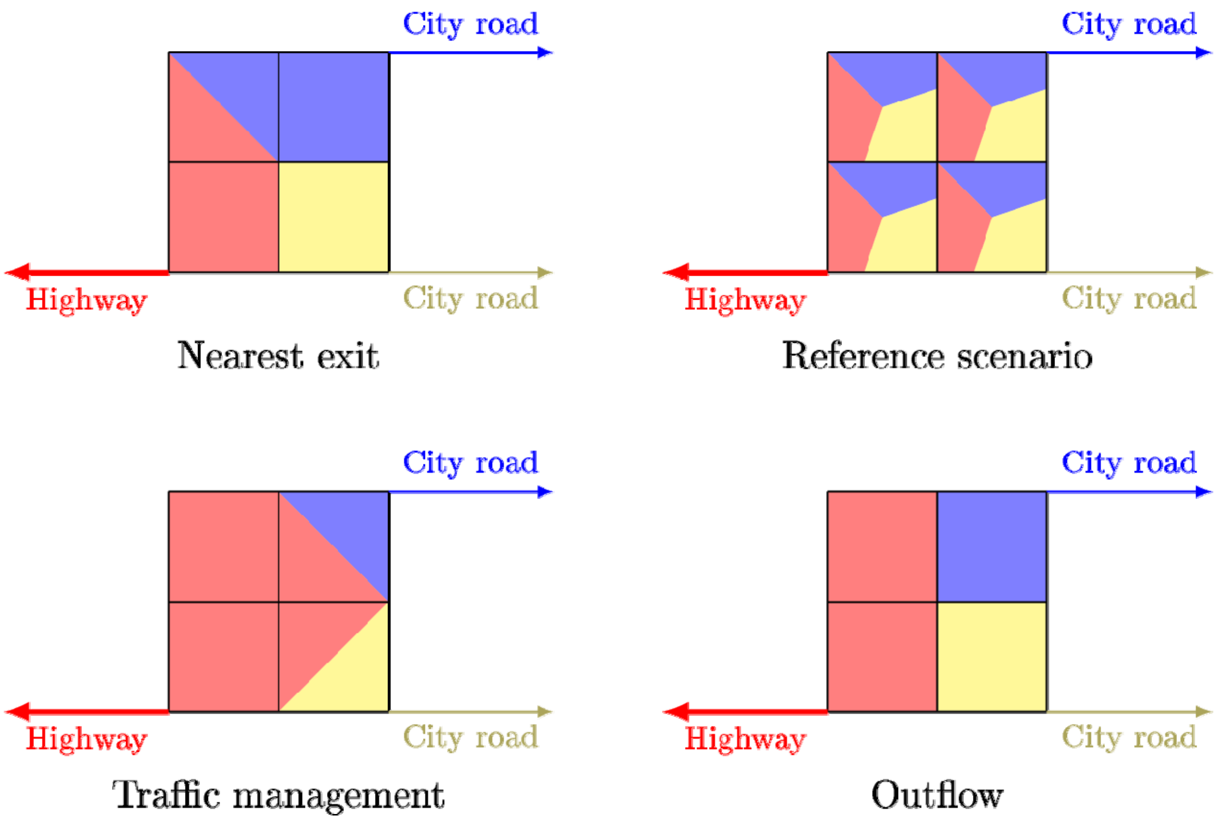


Figure 30: Traffic management scenarios available when using the Evacuation calculator

GOUND TESTING AND METHODOLOGY

DATA COLLECTION

In order to prepare an evacuation plan over a rather broad territory, one first has to make sure a certain amount of data regarding the description of the territory and its inhabitants is available. Only with a sufficient knowledge of the stakes and the resources one can use during a crisis are we able to derive a relevant evacuation plan. Two kinds of information are needed:

- primary data, which can not be easily quantified. Among them are the actual politics and legal framework and the socio-economic characteristics of the population which will influence its behaviour in an emergency context and may dramatically change the way the evacuation is happening. Those characteristics vary accross countries and even across regions and cities. While a general overview of the functioning of a territory can be obtained through thorough interviews with local decision makers and stakeholders, social characteristics can only be tackled by large scale surveys. Moreover, since they are likely to change with the political context or the occurrence of other events far away in the world but nevertheless waking the local awareness of the threat, those surveys should ideally be reproduced at a certain frequency (once every two years for example).

- secondary data descriptive of the region, also evolving in time but usually at a slower pace and which can easily be observed on site provided enough time and money are available to reach the desired level of accuracy. Those data can usually be found in national databases, sometimes spread over multiple governmental organisations.

Face-to-face interviews

Face-to-face interviews should be arranged with representatives of major stakeholders in the considered area. They are useful at gathering knowledge about the organization of crisis management, the responsibilities of the different organisms involved, and the general political context of the site. Usually most of this information is already known by the authority in charge of evacuation planning since it is also a major political actor. However, face-to-face interviews are still useful because they help to share the same view of the sharing of roles and responsibilities between organisms.

Moreover, as many organisms have to be involved in the evacuation as will be seen later in the methodology, one should consider signing commitment contracts between the authority in charge and the organisms involved to describe accurately the amount and types of resources that the latter will provide during the emergency, the actions they will carry out, and the communication with the crisis management cell. The evacuation planner can take advantage of those face-to-face interviews to describe the context and the objectives of the analysis and prepare the future commitment.

Surveys

Large-scale surveys can be carried out to get a better overview of different factors of importance that are not stored in national databases (primary data). These surveys should be made up of questions as closed as possible so as to allow for statistical analysis. When it is possible, one should only let the questioned person choose between several answers. The surveys should at least tackle a representative population in the threatened area but also around it, because it is a known fact that a number of people not directly threatened will evacuate along with the vulnerable population.

The relevant factors cover several fields:

- Knowledge of the hazard: the more a person knows the danger he or she is exposed to by staying in a threatened area, the more likely it is he will decide do leave as soon as possible. This knowledge is strongly related to his own experience of past events in his town or in the neighbouring towns, especially where he himself or his relatives were struck by the disaster, and to the communication about the crisis made by the local authorities. This part of the questionnaire is aimed to assess this level of knowledge.

1. Is your home threatened by a natural or industrial risk? What kind of disaster may occur near your place?
2. Do you know how to behave in case an evacuation order is issued?

3. Are you ready to evacuate as soon as an evacuation order is issued? Do you have stocks of medicines, clothes, food and water?
4. Has your community prepared an evacuation plan? Do you know the contents of this plan?
5. Are you or members of your family involved in voluntary associations that would contribute to the emergency management in case an evacuation is ordered by the authorities?

- Behaviour of the population: this information is needed to know the general behaviour of the population in case an evacuation is ordered. The most important is to evaluate the proportion of people who will stay at home even when the evacuation order is issued, and to get a basic idea of the warning acceptance factor and the warning lag factor.

6. Will you leave your home when you are issued an evacuation order? For a flood disaster / tsunami / chemical spill event / nuclear accident ? (Enumerate here the applicable risks on the area at
7. If you do not want to leave your home, what are the main reasons that make you stay, knowing that the public authorities believe that you life will be in danger? No place to go / No vehicle available / Unable to move alone / Afraid of vandalism or burglary in evacuated areas / Afraid of going outside because of the risk / Overestimated risk and no need to leave / Absolute need of going to work / Not wanting to leave relatives or pets / Other reasons
8. Which actions will you take first right after you are given the evacuation order? If you are at home? If you are at the office? If you are out (recreational activities, shopping)? If you are on the road?
9. How long do you need to prepare to evacuate after being issued the evacuation order?

- Communication channels: those data allow for the identification of the best communication media to issue the warning. However, one should keep in mind that all communication media are not equal. Some of them can cope with individual messages whereas other can only disseminate one message for the whole population. Some also have a more “official” image and better impacts on population when disseminating orders from the authorities.

10. Do you own a phone cell?
11. How often in a day do you read your emails?
12. How often in a day do you watch TV / listen to the radio? Which channel do you watch or listen most?

- Dependent people and people needing special care: sometimes health services databases are not sufficient to locate and count people needing special care. Surveys can then give additional information about vulnerable populations.

13. When you are issued an evacuation order, will you evacuation by yourself of wait for emergency services to help you?
14. If not evacuating by yourself, why do you wait for the emergency services?
15. Do you need special medical care (medicines, equipment, regular treatment)?
16. If evacuating by yourself, will you choose to go to: a public shelter operated by the emergency services / a hotel / relatives / another place?

- Use of vehicles: the number of vehicles used during the evacuation is an important parameter and has tremendous consequences on the movement time and therefore on the decision-making for evacuation. Most often available data on vehicle ownership are aggregated at a large scale, provided by car sellers and previous surveys. One can for example know the average number of cars per family in a city. However, the total wealth in a city is seldom distributed in an homogeneous way. There can be huge differences between the quarters. Since the evacuation will occur at the lower scale of the district, one has to get statistics at this level.

17. How many people are living in your home?
18. How many cars do you own in your family?
19. If you own one or more cars, how many cars will you use in case you decide to evacuate following the instructions?
20. If you own one or more cars, do you intend to share your car with your neighbors / relatives to evacuate?
21. If you intend to use public transportation to evacuate, which transport mode will you prefer?

However, as stated in US Army corps of engineers (1995), “reliable forecasts of people’s responses to hurricane threats cannot be made solely or even primarily from their answers to survey questions about hypothetical situations”. Survey data are only a starting point for the behavioral analysis but to get a better insight of the reactions of the population, a comparison with survey results in other locations and above all with the experience from actual disasters is needed. In coastal areas, another parameter to take into account is the number of tourists which can raise a lot the total population to evacuate during holidays. Thus surveys should not only tackle residents but also some tourists whose behaviour faced to a disaster may be different.

According to US Army corps of engineers (1995, the main objectives of the survey are the estimation of the following crucial parameters:

- the percentage of vulnerable and non-vulnerable population that will evacuate,
- when the evacuating population will leave in relation to an evacuation order or advice given by local officials, in other terms the warning acceptance and lag factors,
- the probable destinations of the evacuees who will probably divide up between public shelters, relatives and friends, close hotels, or rather go far outside the region,
- the proportion of available vehicles that will be used for the evacuation,
- how the population will respond to disaster forecasts and to the information provided by the authorities,
- the specific behaviour of tourists,
- the percentage of evacuees who would require public assistance for emergency transportation.

Quantitative data collection

Along with the results of the surveys, a number of quantitative informations should be collected to get a sufficient description of the territory and the equipment which will serve as a support for the evacuation. Some of them are usually available through national databases and are distributed by a public organism. Sometimes they are free of charge. Since a lot of geographic data has to be obtained, combined, and processed by spatial analysis functions, it is best to get this data in numerical and Geographic information system (GIS) vector format. For small areas however or in countries where accurate vector information is not available, one can try to manually apply the spatial calculations described in the following methodology on paper maps.

This methodology aims to provide a full description of the data needed for the preparation of an evacuation plan. The collection of data shall be the first step of the writing of an evacuation plan. Those data cover 6 themes:

1. Forecasting of the hazard: maps and model outputs used to delineate the threatened area for different hazard scenarios.
2. Buildings: buildings are essential in evacuation planning for two reasons. First they are concentration points of the population. Depending on their use (offices, residential, shops, public facilities), the temporal distribution of their activity varies a lot throughout the day. Offices bring together a lot of people during working hours, but are usually fully empty at night. Residential homes always shelter several people, days and nights, but the proportion of people at home is expected to vary according to the time in the day. Second, some buildings can also be

used as shelters for evacuees when they meet some conditions of distance to the threatened area, availability of primary needs, and access to emergency services.

3. Networks: networks are a crucial component of the evacuation process. Transportation networks (roads, railways, underground network) are necessary to allow people move to safe areas. Electricity, water and gas networks are needed to provide evacuees with primary goods.

4. Vulnerability of the population: the total population inside the threatened area as well as the number of people requiring special care, together with their location at different times of the day.

5. Role-players and organisms involved in emergency management: names and coordinates of every people who would play a role in the emergency management.

6. Real-time information: during the establishment of the evacuation plan, this information is not available by definition. One has to work with assumptions about what will happen, based on one's knowledge and experience. It is possible to draw different hazard scenarios. However, before the disaster strikes, the real-time observations have to be linked to one of the scenarios previously analyzed. Therefore, one should at least know the type of information that will be available real-time, its uncertainty, the frequency of the observations, and how they can be related to the scenarios.

The list of data shown in this methodology may seem very long for the person in charge of building an evacuation plan, all the more so as some of it may be difficult to gather, but it must not scare him. What must be remembered is that this is not a list of required data but a list of useful data. Every element in this list can be used if available to improve the evacuation plan, but the latter can still be made if the element is not available by estimating its value or even deciding not to consider one minor aspect of the evacuation process. A priority has been drawn to identify most needed informations, secondary elements, and elements of lesser importance.

Forecasting of the hazard The first step of the process of evacuation planning is the definition of the risks the territory is subjected to. Then for each of those risks, one can try to map the hazard based on historical observations or numerical modeling.

For this step, one can either build physical or numerical models able to reproduce physical processes which cause the disaster but at a faster pace so that they make it possible to anticipate the event and to get prepared before it strikes. Depending on the kind of event, the size of the territory, the physical interactions with the environment, this method might be very time-consuming and expensive, sometimes not affordable for small communities. Another way to get a good knowledge of how a disaster could occur is to look at historical data.

Knowledge of the hazard	Format	Source	Notes
Extent of past historical similarevents	Studies	Libraries, municipal archives, public authority in charge of monitoring the event	For instance for storm surge disasters, one need to get for some historical events the flood extent (water height and velocity), sea level, storm surge, waves amplitude, wind and river discharge if relevant. For a chemical spill, relevant parameters are concentration of pollutant in the air or water over time, wind or water velocity.
Drivers (“boundaryconditions”) of past historical similarevents	Studies	Libraries, municipal archives	
Historical series ofobservations	Studies, databases	Public authority in charge of monitoring the event, libraries, municipal archives	

For flood and storm surge events, one also needs a topographical description of the territory and a list of defences.

Territory	Format	Source
Topography and bathymetry	Digital elevation model, digital terrain model, GIS format	National geographic institute, local geomatics services, new measurements
Land/sea interface: nature, location	GIS format	National geographic institute, local geomatics services
Defences: location, nature, crestheight, state	GIS format, inventory of defences	National database, defences managers, local geomatics services, new measurements

Buildings First, one needs to get a general overview of the location and use of buildings. Usually this is directly available in national databases, especially because fiscal services use it to calculate taxes related to land ownership. If not, in Europe, one can also make use of the Corine land cover database which holds information about the type of land use, with a rather good resolution, and make assumptions about the density of buildings in each category of zones from the Corine typology.

General building data	Format	Source	Notes
Map of buildings	Preferably GIS format	National geographic institute, local geomatics service, organism in charge of collecting taxes	
Characteristics ofbuildings	Database	National geographic institute, local geomatics service, Corine land cover, GMES	
List of public-access buildings (schools, shops, churches, hospitals…)	Database	National geographic institute, local geomatics service, Corine land cover, GMES	For each building, it is advised to associate the name of the person in charge, the number of people it can shelter, specific measures that have been taken in case of emergency, coordinates of the contact person in case of emergency (name, address, phone number, email address)

Some buildings shelter a large amount of people at some times of the day. For these buildings, particular care should be taken and dedicated measures may be necessary. A list of these buildings and the number of people that can be expected is therefore also needed.

Common data for all buildings	Format	Source	Notes
Type of building	GIS database, preferably	Emergency services (firemen)	If not available, these informations should be obtained directly through field visits
Location of buildings	GIS database, preferably	Emergency services	
Name, address, phone number, email of person in charge	Database	Emergency services	
Plan of building	Documents	Emergency services	
Waterproof qualities and resistance to water	Documents, diagnosis	Emergency services, city property holdings service	
Capacity (number of people who can be accomodated), especially for buildings that will be used as shelters	Database	City services	
Equipments (kitchens, sanitary)	Database	Building manager	
Own electricity generators: total capacity, power	Database	Building manager	

Since some buildings (high, public buildings, large rooms) may be used as shelters, one has to get additional informations about them to check if they can accomodate people for a sufficient amount of time.

Accessibility of buildings	Format	Source	Notes
Accessibility to the building from the roof		Building owner, firemen, construction company or designer	Needed to identify the ways to supply evacuees with food, water, and to check if further evacuation is possible in case the disaster is worsening
Number, size and height of windows per floor			
Presence of a helicopter landing pad			

For buildings which accomodate sensitive persons, one has to get a rough idea of the type and number of these persons.

Capacity of buildings	Format	Source	Notes
Total number of people staying in the building during daytime	Database	Building owner, public authority in charge	
Total staff	Database		

Transportation networks Networks – whether transportation, gas, water or electricty networks – play a crucial role during a crisis. Transportation networks allow the rescue teams to enter the area and the evacuees to leave it. Water and electricity networks are essential to keep evacuees safe in a shelter. If the water of gas networks are affected by the disaster, this may result in indirect threats with the drinking water being polluted or gas leaking in explosive places. That is why the evacuation planner has to collect as much data as possible about the networks.

Transportation network, common data	Format	Source	Notes
Geo-referenced map:location, ordering of lanes, connections	GIS database, preferably	National geographic institution, local geomatics services	Useful for vulnerability studies as well as the assessment of impacts of emergency measures
Networks capacities:discharge per section, lane directions, traffic restrictions (limit height, limit weight,restrictions on cargo)			
Stations (bus, subway,trolley, train): location and accessibility			
Traffic regulation (speed limit, road signs)			
Altitude of network parts, with a reasonable accuracy			A good accuracy is needed to determine if each network part is cut or not. One should at least get two points for every edge, one at the beginning and one at the end. In hilly cities, more points may be required to get a reasonable accuracy, with the errors not being greater than 15 cm. The altitude is mainly needed for flood disasters. If the topographic maps retrieved previously are accurate, one can use a GIS to determine the network altitutes from those maps, by crossing the two layers.
Contact of the organisms in charge of the network: nameof organism, name of contact person, phone number, email	Database	Town services	The contact person has to be able to provide information about the status of the network and stations during the crisis

The road network will be used by most of the evacuees during the flood: cars for self-evacuees and buses for people who require public assistance. Its configuration should allow for grouping of persons at some places to get aboard buses and for a displacement of a large number of cars as fast and free as possible.

Specific data for the road network	Format	Source	Notes
Number of lanes per road section	GIS data, preferably	National geographic institution, local geomatics services	Needed to prepare evacuation routes
Bus stations			Can be used as meeting points for the population
State of the road: road surface, potholes			Useful to identify sections with limited speed or where circulation is not possible at all
Tolls: location, managing company,contact person			One has to raise barriers if an evacuation path goes through the toll
Public or private parkings (with highcapacities): location, owner, capacity,location of entrances, contact person			Parkings can be used as meeting points before boarding buses
Road hoarding: location andcharacteristics of the displaying			Road hoarding is useful to communicate with people in cars during the evacuation
Gas station			A lack of oil can easily hinder an evacuation plan (see Fragos Townsend, 2006). Gas stations have to provide authorities and individuals with enough oil to use the cars and buses. If flooded, gas stations might also burn to fire or explode, which accounts for an indirect source of risk

Railways may also be an alternative for the evacuation of large numbers of people prior to the beginning of the event. As shown by Multimodal corridor and capacity analysis manual, railways and light rails indeed have a high capacity compared to a single road . An appropriate planning of this kind of evacuation should start with an evaluation of the added capacity of this network and a thorough review of its benefits and drawbacks. One of the major benefits is that using trains to evacuate people can substantially relieve congestion on the roads. Furthermore public transportation – since it can be organized prior to the event – reduces the undesirable effects of panic. On the other hand, such a public transportation based evacuation should allow for the discontinuation of normal services during the crisis.

Table13: Transit capacities for different transportation modes (Cambridge Systematics, 1998) under normal circumstances

Type of lane	Capacity per lane
Highway	2 240 vehicles per hour
Railway	18 000 to 30 000 passengers per hour
Airport	40 aircrafts per hour, or 8 000 passengers per hour
Waterway	depends on the service rate of the most constraining lock

Specific data for the railways	Format	Source	Notes
Map of the network	GIS data, preferably	National geographic institution, local geomatics services	Can be used to draw new evacuation paths
Capacity of the network			
Traffic regulation (speed limit, signs)			
Train stations			
Level crossings		Organism in charge of the operation of the railways	Level crossings can cause traffic jams or even make it impossible to use railways during an evacuation
Map of the power supply (lines,voltage transformers…)			Allows to estimate the vulnerability of this transportation mode

For strong events, or when the surroundings of the threatened area are already hit by the event, it is possible to plan airborne evacuations. Planes allow for the evacuation of people when the main access roads to the city are cut or congested. However, the capacity of this mode remains low compared to the roads or the rails, with a maximum of about 8 000 persons per hour and per landing strip. Still, this relies on the assumption that a plane is ready to take off as soon as the previous one left and this requires a very good planning of logistics in the airport. Then, to be able to board on the plane, people have to go to the nearest airport, which may be as difficult and risky as to leave the city. Finally, if many people are gathered in the airport, the structure becomes a very vulnerable place and one has to make sure that it is not threatened by the disaster, directly or because of secundary impacts. Helicopters can also be used and have the advantage of not requiring large infrastructures for the take-off and being able to pick people directly in the city near their homes. However, as only a few crafts are usually available, the total capacity of this transportation mode is very low (a few dozens of persons per hour). Thus helicopters should be saved for people in urgent need of medical assistance.

Specific data for airborne evacuation	Format	Source	Notes
Map of the airports, heliports, helicopter landing stations	GIS data, preferably	National geographic institution, local geomatics services	Care should be taken in the selection of airports because they can also be flooded and the consequences would be calamitous if many people are gathered there
Maps of the airports and their access ways			
Total capacities of the planes and helicopters, fuel stock			

Waterways may appear as a viable alternative to more traditional modes of transportation or can provide extra-capacities of evacuation when the other networks are already saturated. But the preparation of the craft, the boarding of people and the trip itself take a lot of time. Waterways can thus be regarded as an alternative mode only if the decision of using them is taken several hours before the disaster.

Specific data for waterways	Format	Source	Notes
Map of the network	GIS data, preferably	National geographic institution, local geomatics services, organism in charge of the maintenance of waterways, fluvial transportation operators	Can be used to draw new evacuation paths
Capacity of the network			
Traffic regulation (speed limit, signs)			
Navigation equipment (ports, sluices, dams):location, capacity, manager, contact person			Allows to estimate the vulnerability of this transportation mode
Boats: number, capacity, owner, contact			
Gas stations			

Distribution networks Distribution networks include pipes, wires, transformers and all devices related to the distribution of electricity, gas and water. This kind of goods are usually necessary to ensure safety and a minimal comfort for people at home or evacuees in a shelter. However they can not easily be stored in amounts large enough to fulfill the needs of a family for a few days. The connection to functional electricity and drink water networks is therefore a required condition for a building to be considered as safe enough for its occupants to live in during the crisis. The vulnerability assessment carried out at the start of the evacuation planning shall include considerations about the state of the networks and their potential bottlenecks.

Electricity network is the most sensitive one because most activities nowadays rely on devices powered by electricity: telecommunication, cooking, medical devices, lights. At the same time, electricity is the primary good which is the most difficult to store. The energy has to be consumed the very same time it is produced at a more or less far power plant.

Electricity network	Format	Source	Notes
Map of the network	GIS data, preferably	Organism in charge of maintaining the network	Needed for a full vulnerability assessment, including secondary impacts due to the cut of some parts of the networks
Height of lines (aerial, underground)			
Location of voltage converters, and approximative zone which wouldexperience a power shortage in case of failure of one of the converters			

Water is nearly as crucial for a living as electricity. Drink water is of course the primary need, but larger amounts of water are used for washing and cleaning. Its only advantage on electricity is that drink water can be stored in small amounts, at least enough for a few days. For places meant to be used as shelters during a crisis, a good practice is to store bottles of water in case they are cut from the network or water is polluted.

Water network	Format	Source	Notes
Map of wastewater network	GIS data, preferably	Organism in charge of maintaining the network	Needed for a full vulnerability assessment, including secondary impacts due to the cut of some parts of the networks
Map of drinkwater network: type of network, location ofpipes, potential places of contamination by the outside			
Capacity of the wastewater network			

Communication networks Telecommunication networks are the only reliable way to transfer information fast between authorities and citizens during the crisis. However, those networks are also vulnerable to a disaster. If they are not working, one has to rely on more traditionnal means: going from door to door, shouting a message through a loudspeaker. Even though we saw that there is a real need and demand for a quality real-time information about the state of the event. Only telecommunication tools can achieve this purpose. Phone and GSM is the preferred channel of communication. Due to the strong demand at the time of a crisis, authorities should not rely too much on one single channel. Broadcast media (TV, radio) are less sensible to a local event and help disseminate the message. Finally Internet can provide the citizen with a richer and more detailled information, sometimes adapted to his location, but at the cost of a more complex and therefore vulnerable system, more distance to where the event struck which can lead to people feeling less concerned about it, and lots of data hiding what is really important for the end-user.

Communication networks	Format	Source	Notes
Map of the phone and GSM networks: antenna, saturation level, vulnerability and location of relay-antennas, location of operating consoles of the antennas, emission area	GIS data, preferably	Organism(s) in charge of the operation of the network	GSM networks are one of the best way to communicate information and instructions to people
Map of the emergency services network andlocation of antennas		Ministry or department in charge of the emergency services	Necessary for the communication between emergency services and firemen
Map of the town fire sirens and loudspeakers: location and service area		Town services	Loudspeakers and fire sirens can be used to transmit information when the other networks do not work any longer
Map of CCTVs: owner, contact person, watchedperimeter, location of monitoring centers		Town services	In some cities that have set up such devices, cameras can be used to monitor the state of the event (especially for flood events) and the way the evacuation is going from the city emergency response unit. When the area has been evacuated, CCTVs are useful for law enforcement.

Population Population is obviously the most important data to collect in the evacuation planning stage. The number of self-evacuating people and people requiring assistance allows to estimate the rescue staff and the material needed. Accurate data about the population location are usually available thanks to regular census. Since population distribution changes between two census, with people moving from one place to another, babies being born and persons dying, getting the exact number of persons per building is hardly possible unless the city or the state keeps an up-to-date database and continously monitors the changes. Moreover the registration of individual data is bound to cause trouble if the law protects the privacy of indivual data. Therefore it is usually only possible and desirable to collect population data at a larger scale (entire city or district).

However if the population safety compels it – for instance when the evacuation of some people requires the assistance of rescue services and particular medical devices – it is perfectly natural and lawful to gather additionnal data at a smaller scale. By sending questionnaires or by going to every houses in the threatened area, one can identify old people or persons requiring medical assistance in case of an evacuation and store the list in a database. In those cases, it is advisable to regularly renew the survey, once every two years at least, and to update the evacuation plan according to the results. The number of vulnerable people per house or building should be written in an appendix of the evacuation plan. When updated, the different chapters of the plan – and especially those dealing with rescue staff and specialized material – must be checked for compatibility with the actual number of people to evacuate.

Three kinds of people requiring special care in an evacuation can be identified:

- assisted evacuees:
    - people who are not able to evacuate on their own because they do not own or have access to a vehicle. This group includes some disabled persons, but also self-contained people without sufficient financial resources. Most of the assisted evacuees will be found in disadvantaged districts. This category needs a light assistance to move away from the threatened zone, by giving them access to public transportation. The accurate knowledge of the condition of these people is not needed, nor is their exact location: only the number of assisted evacuees is important to estimate the needs of public transportation.
- vulnerable groups:
    - people who are not able to seek shelter in second homes, hotels, or relatives and therefore rely on public shelters. This group includes persons without local social networks, with low financial resources. Tourists and homeless usually meet those criteria, and they are a challenge for evacuation operations because their numbers are imprecise and variable and, since they are not tackled by preventive awareness campaigns, they may not know how to evacuate, where to seek shelters and where to access help.
- dependants:
    - people whose age, medical state or legal status makes them require continuous assistance from a third party, and sometimes the use of special medical devices. Based on their condition, these people may need an access to medicines, medical or nurse care, tight surveillance, or even large medical devices like breathing apparatus linked to a functional source of electricity. For those people, whose number should not be too large, one has to identify precisely their condition and the special care and equipment they need. This can be achieved by sending questionnaires around or by getting these

informations from hospitals and medical staff. Dedicated shelters for dependants have to be allocated in places far enough from the evacuated area so that no further evacuation is needed if the disaster gets worse. As stated in (Ministry of civil defence, 2008); a thorough understanding of the nature of health care facilities in the community is vital so that evacuation plans can reflect requirements that will be needed to support evacuees, especially when evacuees are accommodated out of the region. Among the dependant people, prisonners must not be forgotten and they also need to be moved early in case of evacuation. Finally, one of the most vulnerable groups is childrens, found in schools and child care centres. Due to their vulnerability to psychological stress, evacuation planning has to be particularly mindful of the welfare needs of children. Moreover, those actions have a major influence on reducing the distress of their parents.

When dependant or vulnerable people are taken care of by a public or private institution (hospital, nursing home, hospice, school), an arrangement should be made between this institution and the authorities to define the actions that the institution has to take when the evacuation plan is lauched. Indeed, the institutions often have a better knowledge of the number of persons under their responsibilities at a certain time and the special needs of those persons. They also have trained staff and equipment suited to the disabilities of their residents. The terms of the arrangement should be written in a contract, and renewed at the same frequency as the evacuation plan.

Population	Format	Source	Notes
Number of people per street	Data table, GIS data	National institute in charge of census, town services	If not available, this number can be estimated by extrapolating larger scale data (see further)
Temporal distribution ofpeople (day/night, week days/week-ends, schoolyear/holidays)	GIS data, preferably	Surveys	This data is most needed for emergency evacuation. Indeed, the temporal distribution of population varies a lot across the day. At night, people are mostly at home. During the day, they are at the office, in shopping places, doing recreational activities…If the event can be anticipated enough (16 hours or more), the evacuation strategy can include a rather long warning lag factor so that even if the evacuation order is given during daytime, people have time to leave the place they are and go back home, possibly fetch their children at school, pack and leave long before the start of the event. In those cases, the temporal distribution is not relevant.
Number of vehicles perhousehold	Data table	Surveys	Allows to estimate the number of assisted evacuees. The number can vary from district to district. If it is not available, one can use larger scale data (ratio in the whole town, or in the region).

Dependantsand vulnerable groups	Format	Source	Notes
Number of vulnerablepeople per street	Data table, GIS data	Surveys to households, nursing homes, tourists centers, town services, voluntary associations	This number gives a rough estimation of the places needed in shelters. If no data is available at the street level, one can use data at a larger scale and use the same ratio of vulnerable people over the total population for the street level. Voluntary associations hold data on the homeless people that would not be tackled by usual surveys. Tourists centers and town services can provide statistics about the number of tourists and their location in the town. Vulnerable people other than tourists, homeless, old and disabled people can be located by surveys, or their number can be estimated by general ratios.
Address of dependants	Directory	Surveys to population, medical staff, hospitals	Allows to estimate the needs of medical staff, dedicated shelters, medical equipment, special transportation vehicles…
Contact of dependants: phonenumber, email			
Special needs:medicines, equipment,medical care			

Organizations, equipments and staff As stated previously, contracts have to be concluded between the authorities and the different organizations that will take part in the operations. The purpose is to get an idea of the total staff available for emergency management and the type and number of equipments that can be used. For public organizations under the responsibility of the state, a contract is not mandatory but it is generally good to associate them to the planning stage. In all cases, answers to this data collection table shall be commitments of the organizations to make staff and equipment available when told to by the authorities. Those commitments are reflected by internal rules, restraining the use of the resources for other purposes. The figures in the following tables (unnumbered) are therefore minimum numbers of resources one can rely on. More can be available at certain periods of time but one can not take them into account in evacuation planning.

When local resources are overwhelmed, local municipalities can ask for support to national (or federal) authorities. However, due to the greater time needed to allocate the resources and bring them to the field, this solution can only be used if there is sufficient time to prepare for the evacuation. Besides, getting too many resources on the field may complicate the planning and management of the crisis and induce more traffic jam. Last, if the disaster is expected on a large area, neighbouring communities or national organisms whose support is asked for may also have to deal with their own emergency plan and not be able to provide this support. Therefore, the best practice is to plan the evacuation as far as possible with local resources and equipments and only rely on external resources when no similar equipment is available locally (planes, helicopters, boats, high-technology device) or when local means would clearly be really insufficient to manage the crisis. In the following, the word “organization” refers to every institution that would be involved in crisis management, public or private, local or national.

Organizations	Format	Source	Notes
Name, location(s), address and phone number, contact person	Any format, electronic is better	Town services, state departments / ministries under the responsibility of which the organizations are placed	Allows to know human and material resources available for emergency management
Total staff, number of staff available during crisis(can be mobilized in a small period of time)			
Equipment: location, nature, capacity, number, specific data			

For public services with an assignment of rescuing people (firemen, police, emergency medical services, hospitals, army), more accurate questions can be issued.

Rescue services	Format	Source	Notes
Equipment: beds with linens, medicalequipment, specialized cells	Any format, electronic is better	Town services, state departments / ministries under the responsibility of which the organizations are placed	Allows to know human and material resources available for emergency management
Vehicles: usual transport, medical			
Vehicles: transport of equipment,mobile command vehicles			
Staff: doctors, volunteers,logisticians, technicians			
Staff: administrative, managers			

Some organisms will be called upon to make available their buildings as shelters for evacuees. This is especially the case for schools, gymnasiums, conference halls, churches, and more generally every large sheltered and safe place without any valuables that can accommodate at least one hundred people and have access to power, drinkwater and a communication network .

Shelters	Format	Source	Notes
Electricity generators: number, total power	Any format, electronic is better	Organisms, town services, state departments / ministries under the responsibility of which the organizations are placed	Allows for the estimation of the total capacity of shelters.
Food and drinkwater stock			
Free surface available for accommodation (including commonplaces, showers, kitchens, toilets, but excluding the space occupied by furnitures)			

Making stocks of first-need supplies in considered shelters before the actual disaster is crucial as shown by the Katrina experience. When the stocks of shelters are not sufficient to accommodate evacuees at their full capacity, rescue services and town services can help by delivering supplies regularly during the event. Thus a well-prepared evacuation planning shall take into consideration own stocks of rescue services.

Rescue services, town services	Format	Source	Notes
Vehicles : transport ofequipment, tow trucks	Any format, electronic is better	Organisms, town services, state departments / ministries under the responsibility of which the organizations are placed	Allows for the estimation of the total capacity of shelters.
Electricity generators:number, total power			
Mobile pumping stations: power, discharge			
Barriers, mobile levees			
Food and drinkwater stocks			

Operators of public transportation will play a major role in the evacuation. They can help to move dependants to their shelters. In large cities where traffic jam and congestion occur, people should be urged to use public transportation instead of their own vehicles because this can greatly reduce the burden of managing traffic. However, even with appropriate communication from the authorities, only a limited proportion of the population will use public transportation. Transportation firms should also answer to the questionnaire on data collection, with the purpose of defining the total public assisted evacuation capacity. Once again, if public companies do not have enough vehicles to fulfill the needs of the evacuation plan, it is always possible to have recourse to private firms, providing an agreement with them was concluded during the preparation of the plan.

The evacuation plan can take the following firms into account:

- private transportation firms,
- military regiments with transportation equipment,
- driving schools,
- taxis companies,
- car renting companies,
- fluvial or maritime ferries if relevant,
- buses companies, light railways and subways.

Transportation firms	Format	Source	Notes
Vehicles: number,type, capacity	Any format, electronic is better	Public transportation operators	Used to estimate the total capacity of public evacuation in a given time.
Power supplies: gas stations,electric receptacles			The Katrina example showed that it was very important to make sure all elements (fuel and staff) needed are present at crisis time. For human resources, one has to establish contracts with the employees to define their roles in the emergency management and on-call duty in case of disaster.
Human resources:drivers, mechanics			
Human resources:administrative, managers			
Location ofvehicles depots, number of vehicles			Only vehicles that are not too far from the threatened area and able to reach it will be of any use. This part helps to identify those vehicles. If the usual path is cut by the disaster but an alternative path is still in use, drivers must be informed of the road cuts and advised with a new possible path to their destination.
Usual path and location of stops			

Real-time data Finally, even well-prepared evacuation plans can not tackle all scenarios that are bound to occur on a territory. Unforeseeable events may disrupt the way the evacuation is going. To prevent those disruptions from slowing down the process or even stopping it, one has to gather relevant data during the whole crisis period. The use of this data is out of the scope of this guide, but in the preparation stage, it is advisable to determine what kind of data will be available real-time, and who can produce it. If the data need special treatment before being used by the decision makers, routines to do those operations can be prepared before the crisis.

Meteorological data are only necessary for climate-related disasters (floods, storm surges, hurricanes).

Meteorological forecasts	Format	Source	Notes
Rainfall, wind speed	GIS, preferably	National meteorological service	Allows to determine the evolution of the event.
Sea level: tide level, waves, river discharges, level of groundwater	Data tables	National meteorological service, flood forecast services, organism in charge of tidal forecasts, organism in charge of storm surges forecasts	For flood events, allow to determine the maximal extent of the event and the level of safety of shelters.

The number of persons in some buildings varies a lot over time, and it is therefore advisable to check those numbers just before the event. This is especially the case for hostels, youth hostels, camping places, resting places. Having a list of establishments with the associated number of people can help estimate the number of vehicles needed for evacuation.

Buildings	Format	Source	Notes
Number of people to evacuate (residents and visitors)	Data tables	Contact person in the organism	Allows to determine the number of people to evacuate, or – for shelters – the remaining capacity

On the transportation networks, public works may affect circulation: some roads may be cut, others can only be used in one direction, or at a lower speed. Getting this information is crucial to avoid planning an evacuation through a path that is actually not usable.

Transportation networks	Format	Source	Notes
Location of workingssites	GIS data, preferably	Town services, roads operators, public works department / ministry	Allows to identify roads cut and to improve paths of the evacuation vehicles

Overview of the methodology

SADT diagrams The evacuation plan has to be written by local communities or consultants hired by them for they are responsible for the sake of their people and have the best knowledge of their territory. The whole process of writing the plan can be considered as a list of actions taking as inputs data about the territory described in the previous section and producing as the output the evacuation plan. The full work is quite complex so a structured analysis and design technique (SADT) has been used to describe it. This representation is well suited to complex processes and offers nested views of the basic tasks that have to be done, as shown in Figure 31 below.

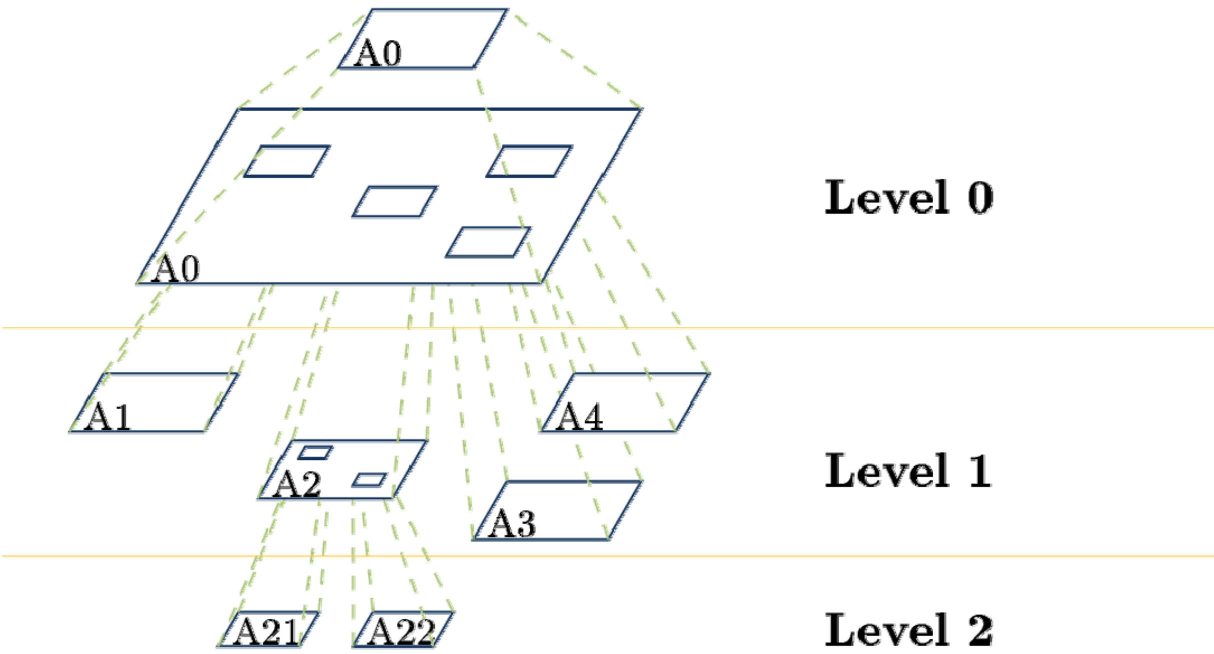


Figure 31: Principles of a SADT diagram, with nested levels. High levels at the top gives an overview of the whole function whereas low levels at the bottom represent basic tasks.

A function is characterized by its inputs – the raw material it will operate on, its outputs – the final products, its resources – the tools used to work on the raw material, and its constraints – rules it has to cope with. According to the standards of representation of SADT diagrams, a function can be represented by a box with a verb in the infinitive form describing the task, and arrows all over its sides defining its context, as showed on the following figure (31).

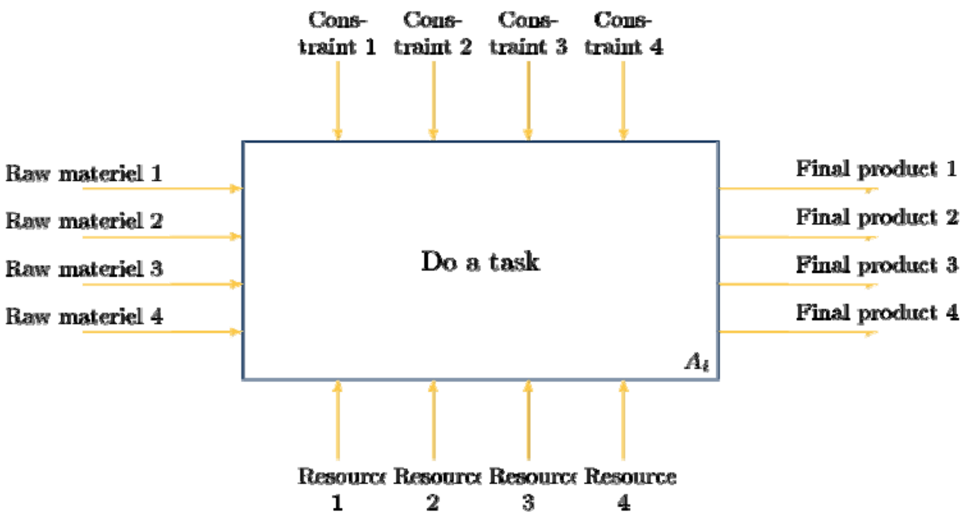


Figure 31: Example of SADT box

This symbolization will be used in the following sections to describe the successive stages of the preparation of the evacuation plan.

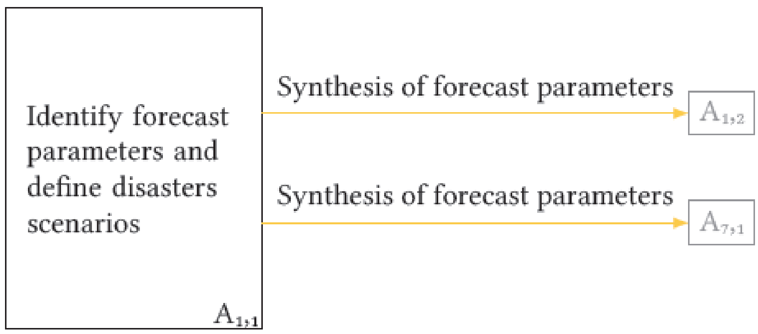
General overview Under the previous conventions, the whole process of evacuation planning can be summed up on a diagram like the one on in Figure 32 (next page). In the following methodology, we will detail the functions of each box.

DEFINE PARAMETERS AND SCENARIOS

This first stage is aimed at producing a set of scenarios and hazard maps similar to what can be expected from an actual disaster. It is crucial for the preparation of evacuation plans. The later vulnerability assessment results from those hazard maps, as well as the list of shelters and the evacuation paths.

Scenarios result either from physical and numerical computations or from the knowledge of past events, recorded in city archives or kept in the memories of the population. This stage is common to other emergency management plans, and usually the work has already been done before the mass evacuation plan is prepared. However it is described here for the sake of comprehensiveness.

Identify forecast parameters and define disasters scenarios



First, the evacuation planner has to identify the different types of hazards the town is faced to. This is usually done in other risk evaluation documents, for instance in documents used for spatial planning. In this methodology, we are only interested by hazards that may require a mass evacuation. This excludes very local disasters (such as a building fire), very large scale disasters for which an evacuation is not possible (national pandemy), or sudden events that are unpredictable (explosion of a factory).

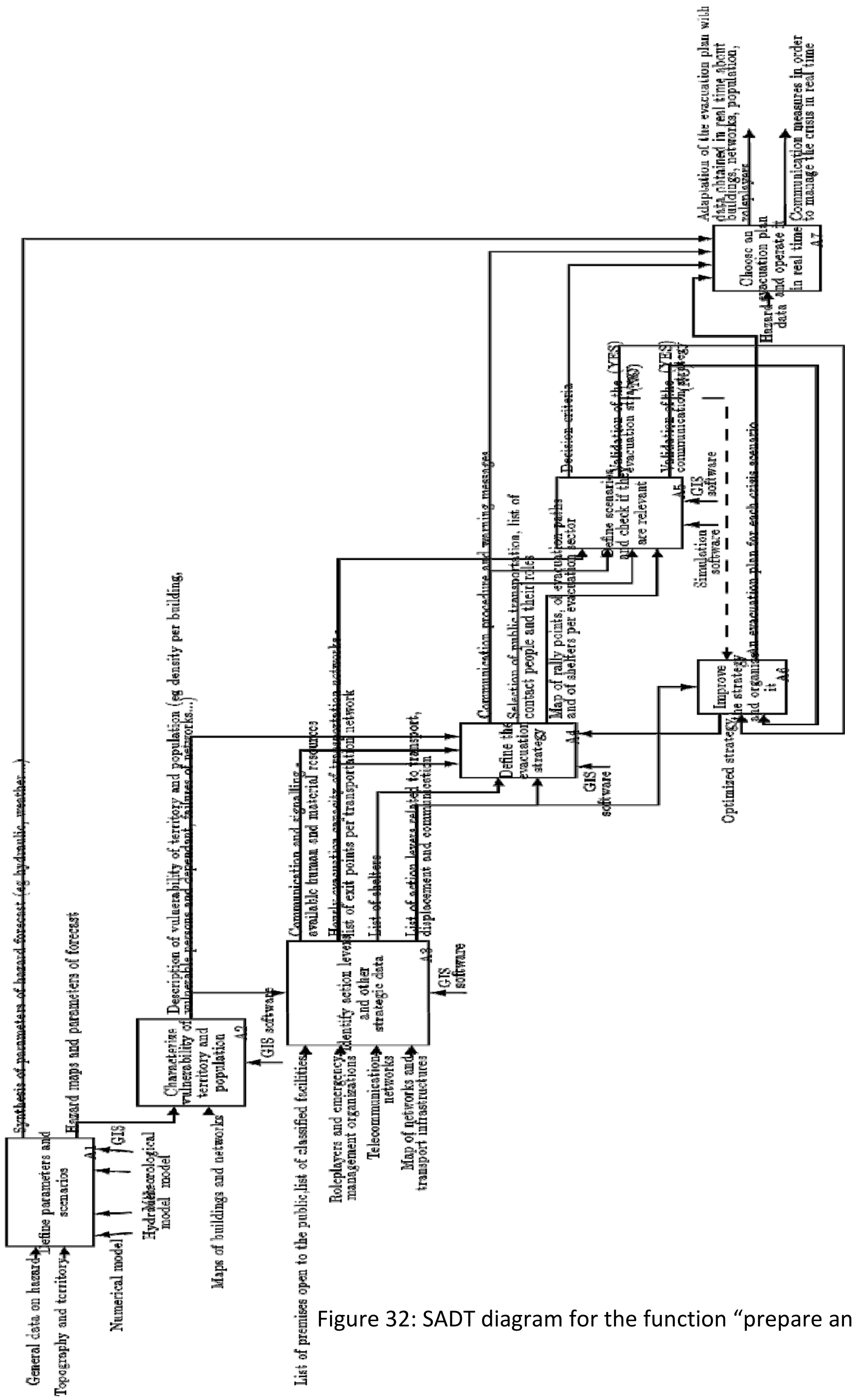


Figure 32: SADT diagram for the function “prepare an evacuation plan”

Since one of the assumptions of this methodology is that we are dealing with preventive evacuation prior to a predictable disaster, the authorities should be able to guess the probability of occurrence of a disaster in the near future based on forecasts of physical parameters. For storm surge, those parameters could be for instance water levels at different locations near the town and for different moments. In case of a hurricane, wind peak velocities are well suited for the description of the disaster. The evacuation plan should describe the nature, time frequency, delay of forecast, relative reliability and uncertainty of each of those parameters. A contact person in the organism producing the forecast is also needed in case one needs more details about the forecast or if the automatically transferred parameter has not been received by the decision making authority.

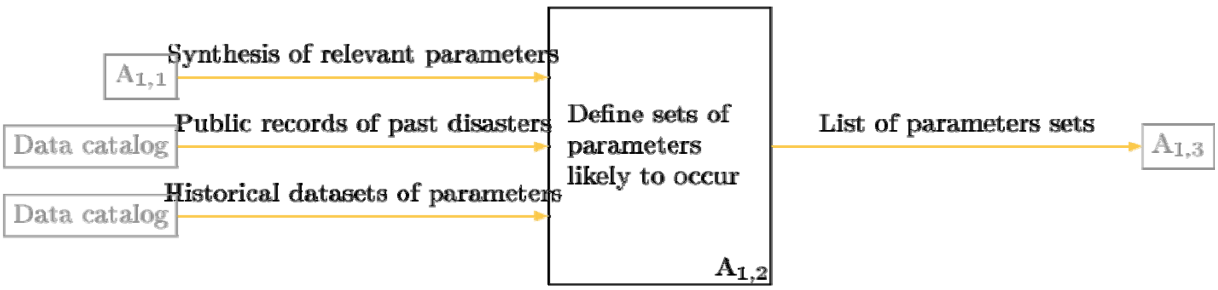
This work has to be done for every identified hazard. Different hazards may lead to different sets of parameters.

Example

Forecast parameters

Parameter	Organism	Contact	Frequency	Reliability	Anticipation	Uncertainty	Comments
Water level near building A	Water observation service	John Doe, +33 (0) 344 926 086	Every 10 mn	Very reliable measurement, rare failures, close to the evacuation sector	24 hours	About 5%	Water level is expressed in cm above ground. Position of the sensor : 2°15'56.456"W, 44°59'58.355"N
Water level in neighbouring town	Water observation service	Jane Doe, +33 (0) 344 926 086	Every hour	Regular breakdowns, may differ from actual water level	48 hours	About 10%	Water level is expressed in mm above ground.

Define sets of parameters likely to occur



When forecast parameters have been identified, one can establish hazard scenarios. Those should reasonably well describe expected disasters, that is every potential disaster has to be close to a pre-established scenario in terms of intensity and exposed area. This constraint usually requires a large number of scenarios. However, the time needed to prepare an action plan for a given scenario may be quite long and thus, one shall find a balance between a small number of scenarios and the assessment of all potential hazards. Four to six hazard scenarios are usually a reasonable choice.

If the exposed territory has already been struck by disasters in the past, one can contact the different services involved in the forecasts, monitoring and emergency management and ask them for information about the extent and intensity of the disaster, its consequences on buildings and protection structures, and the way the emergency services responded to it. However, due to changes in the town spatial planning, the building of new protections, hazard scenarios continuously change during time. One has to update them regularly based on new knowledge or even establish a new set of scenarios if a lot of changes has taken place since the last one. A two-years frequency was advised for conducting the surveys on the population. The same frequency for the update of the hazard maps is thus usually a good choice.

A hazard scenario can be built in two ways:

- either it is a “worse known disaster” which is a historical event described in the literature, the city’s archives or which is still present in the memories of the inhabitants. The advantage of this method is that one has easy access to the damages in the field caused by the disaster. Nevertheless, this method is only seldom used because the historical records of past events are often not long enough to encompass large-scale disasters comparable to those the planner wants to analyze. Even if long records are available, it is very unlikely the physical configuration of the territory did not change at all during this period. Therefore, even with the same boundary conditions as the previous disaster, the resulting consequences in the town may be very different.

- or it may also be the result of a statistical analysis combined with physical models. Statistical models allow to extract extreme values of distant driving parameters of the hazards (forecast parameters identified above), while the physical or numerical model translates these extreme values in consequences in the city. This approach is very commonly used for sizing protection structures. Getting the results of such a past study can therefore be of extreme interest since it may release the planner from the burden of estimating new hazard scenarios from scratch. Scenarios built according to this method are usually based on a “return period” – when expressed in years, the inverse of the probability that the event occurs during a year. The choice of return periods to be taken into account has to be made by the decision maker, in accordance with state laws and depending on the level of preparation he wants to apply. Scenarios for 10-year, 25-year, 50-year, 100-year return periods are advisable if relevant5 . At least one extreme event (with a 1 000- or 10 000-year return period) should also be taken into consideration because in this case, the community may not be able to rely only on its own resources and will have to ask for external materials and assistance. The evacuation plan will therefore be quite different in this case.

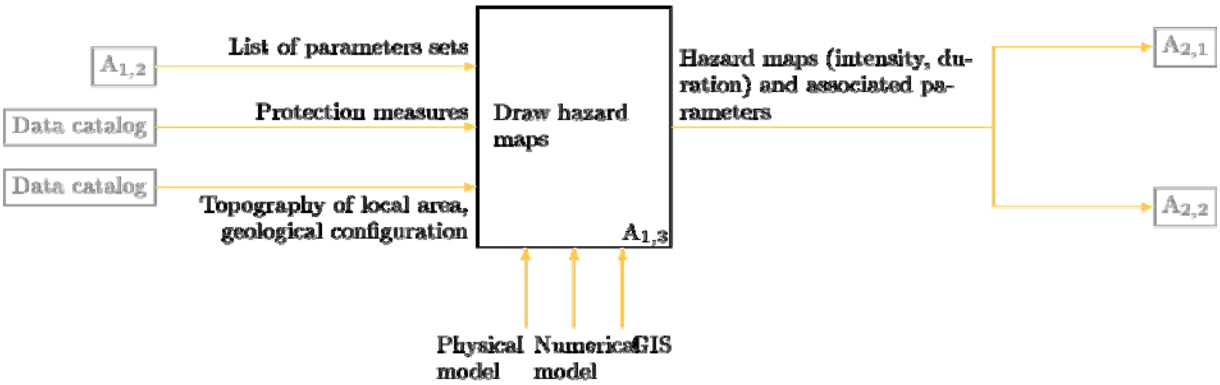
The hazard scenario is described by a set of parameters, distributed on a spatial area close to the threatened area and on a relevant period of time. This set of values should be sufficient to describe the intensity and the spatio-temporal extent of the disaster. Based on the assumptions of this methodology, the relevant parameters must of course be measurable and predictable.

Example:

Hazard scenarios

Scenario	Water level	Storm surge	Wind velocity	Water discharge
High tide (return period: 100 years)	2 m	0.40 m	10 m/s	200 m^3/s
Extremely high tide (return period: 1000 years)	2 m	0.80 m	10 m/s	200 m^3/s
Strong storm (return period: 100 years)	2 m	0.50 m	38 m/s	200 m^3/s
River event (return period: 100 years)	2 m	0.30 m	10 m/s	1600 m^3/s

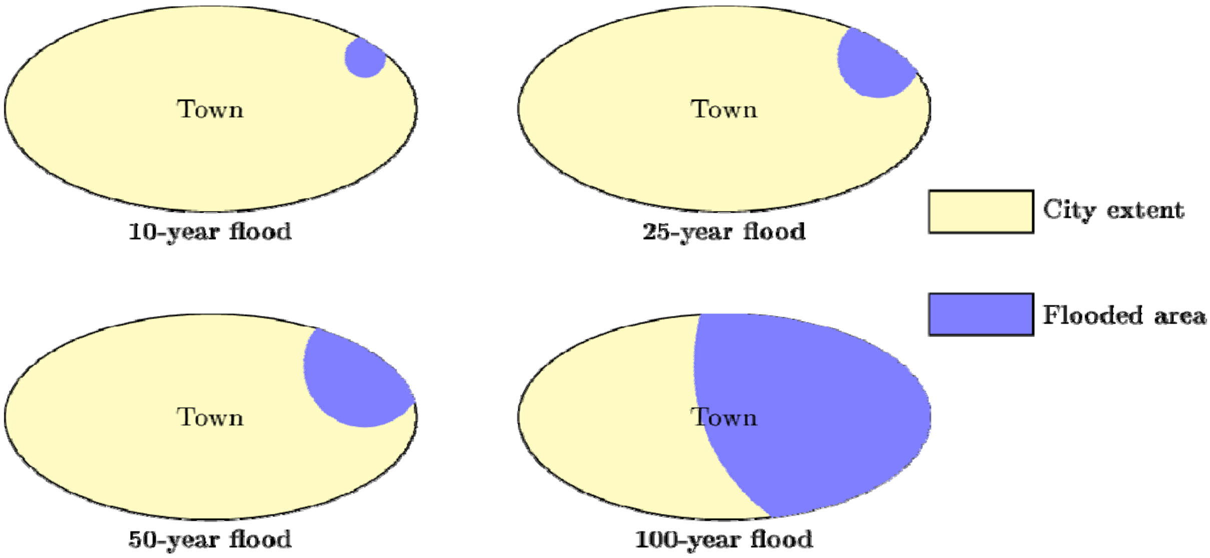
Draw hazard maps



From the sets of discrete parameters established for each hazard scenario, one then has to produce hazard maps describing how the disaster will occur in the city. For floods or storm surges, a disaster map will actually be a set of maps showing the extent of the flood and maybe the water velocity at different time steps. For hurricanes, the disaster map should show the maximum wind velocity in the town during the event.

The drawing of maps if usually achieved by applying a numerical or physical model which boundary conditions are defined by the set of parameters obtained from the previous step of the methodology. An accurate knowledge of the geographical configuration of the territory is helpful: topography, geology of soils, location of buildings change the way the disaster propagates in the city. When no numerical model is available, one can rely on damage maps from past events, taking care that the geographical configuration of the city has only hardly changed since those events.

Example:



CHARACTERIZE THE VULNERABILITY OF THE TERRITORY AND THE POPULATION

From the hazard maps drawn previously, which are compared to population maps extracted from national databases or surveys, we are now able to define the risk and the need to evacuate people. At this stage, we identify areas to evacuate and places where people will seek shelters.

Without further knowledge of the level of individual protection of the inhabitants against the disaster, the decision maker shall assume all the inhabited territory is vulnerable. This is a pessimistic assumption since many people actually live in safe places with regards to the disaster. For instance, people living at the top floors of high buildings resistant to water are quite safe when a flood occurs. When a hurricane strikes a city, it is usually safer to stay in the basement of one's house. The choice of making people leave the zone or stay at home is up to the decision maker based on his experience of past disasters and his knowledge of the behaviour of the inhabitants. Nonetheless it is important to realize that panic movements and secondary impacts of the disaster can dramatically reduce the safety level inside the impacted area. Therefore one should not rely too much on them and underestimate the measures needed to protect the population.

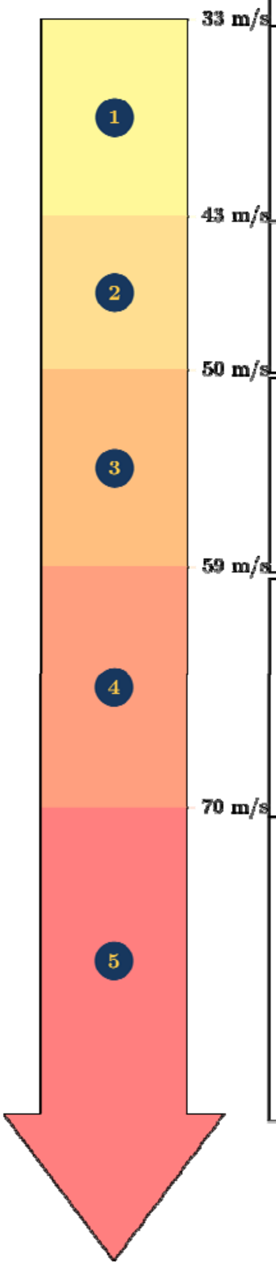
Networks (electricity, communication, water) are an important part of an urban system and many people depend on their good functioning. Their state determine if a place can be used as a shelter or not, or if an individual home is still in good condition to provide for a safe and rather comfortable living. It is thus crucial to assess their vulnerability in regards to the hazard. What makes them particular in the study is the fact that even if an area is not directly hit by the event, it may not be safe any longer because neighbouring networks are out of function. The threatened area is then larger than the actual exposed area obtained from hazard maps.

Identify the vulnerability of the population

The purpose is here to produce a map of the threatened buildings and places. This map is the result of a crossing between the hazard map for a given scenario and a plain map of the buildings associated with their usage. This will help to determine later the number of people that are potentially threatened by the coming disaster, as well as secondary consequences of the event (when a vulnerable factory or public building is in the dangerous area). This work has obviously to be done separately for each hazard scenario previously defined.

In open areas (outside buildings), people are particularly vulnerable to high levels of water above ground and flying objects which can become deadly missiles when velocities are high. The level of danger of a building is not easy to determine, even with accurate data about the disaster. It depends on its material constitution, on its state, on the design of its components.

Wind-related damages and fatalities Some studies were carried out in the past years to help estimate the damages causes by different disasters. As far as wind is concerned, hurricanes can cause severe damages to buildings but on coastal areas, the main threat still comes from the sea with storm surges caused by high winds. A relation between the wind speed and the consequences in the field are given by the Saffir-Simpson scale, summarized in Figure 33 below. This scale is adopted by the United States national weather service.



People	Buildings	Coastline	Evacuation
May be injured or killed by falling debris	Minor damages to poorly-constructed buildings, breakage of windows, unanchored mobile homes toppled, widespread power outages	Some coastal flooding, minor damages to piers	
May be injured or killed by falling debris	Some houses lifted, structural damage to houses, extensive power outages for many days, loss of potable water	Considerable damages to piers, coastal flooding, breakage of moorings of small crafts	Evacuation of homes near the coastline
May be injured or killed by falling debris	Destruction of mobile homes, gable-end roofs peeled-off, severe damage to manufactured homes, near-total power and water loss up to several weeks	Destruction of small coastal structures, large ones struck by debris, extensive coastal flooding	Evacuation of homes in low-lying territories
May be injured or killed by falling debris	Roof structural failure, mobile homes leveled, total power and water loss for several weeks	Coastal flooding up to 9 kilometers inland, beach erosion	Evacuation of one-floor houses at less than 400 meters from the coast, evacuation of two-floor houses at less than 3.2 kilometers from the coast
May be injured or killed by falling debris	Complete roof structural failure, some buildings blown away, destruction of mobile homes	Major damage to lower floors, coastal structures washed away, storm surge damage up to four city blocks inland, coastal flooding up to seven city blocks	Massive evacuation of residential areas up to 16 kilometers from the coast

Figure 33: Saffir-Simpson scale of wind hazard

Water-related damages and fatalities For flood hazards also, methods have been developed to estimate the damages of a disaster with respect to the physical parameters of the flood (height of water, velocity, increase rate). Those “mortality functions”, established based on data gathered from a limited number of events, need to be considered with care as they may differ from one country to another, depending on the age of the population, its awareness level of the risk and a lot of other parameters. One of the most recent flood mortality functions is given by Jonkman, Vrijling, and Vrouwenvelder in Jonkman et al. (2008), and it takes into account the water height, its rate of rising, and the possibility of evacuation given the location of the flooding (close to a dike breach or farther inland). The proposed formulas are calibrated on six real disasters which occurred between 1934 and 1965.

Jonkman et al. distinguish between three areas where the impacts of the flood will be different:

- a breach zone, directly behind a breach in a dike, where one is bound to find very high velocities and forces resulting in collapses of buildings and destabilization of people. This area is characterized by hv ≥ 7 m2/s and v ≥ 2 m/s, where h stands for the average height of water and v is the water velocity. In this case, the mortality function equals to 1, which means all people remaining in this area will die from the flood;
- a zone with rapidly-rising water when not in the breach zone and h ≥ 2.1 m and w ≥ 0.5 m/h (with w the rate of rising of the water). In this case, the mortality function giving the individual probability of dying because of the flood may be computed by the following expression where ΦN is the cumulative normal distribution function:

$$F_D(h) = \Phi_N\left(\frac{\ln(h) - 1.46}{0.28}\right)$$

- a remaining zone outside of the breach zone and of the rapidly-rising water zone, where slow-onset flood conditions offer better possibilities to find shelter. The proposed mortality function is then:

$$F_D(h) = \Phi_N\left(\frac{\ln(h) - 7.60}{2.75}\right)$$

The corresponding mortality functions are represented in Figure 34 below. Once again, when comparing predicted mortality with real observations after actual disasters, large differences can be found. In the remaining zone for instance, the correlation coefficient between observations and model calculations in not higher than R2 = 0.09, a very weak value due to some disasters resulting in a lot more fatalities. The mortality functions must not be used as a general truth, but they can give very rough ideas about the expected losses of life in a flooded area.

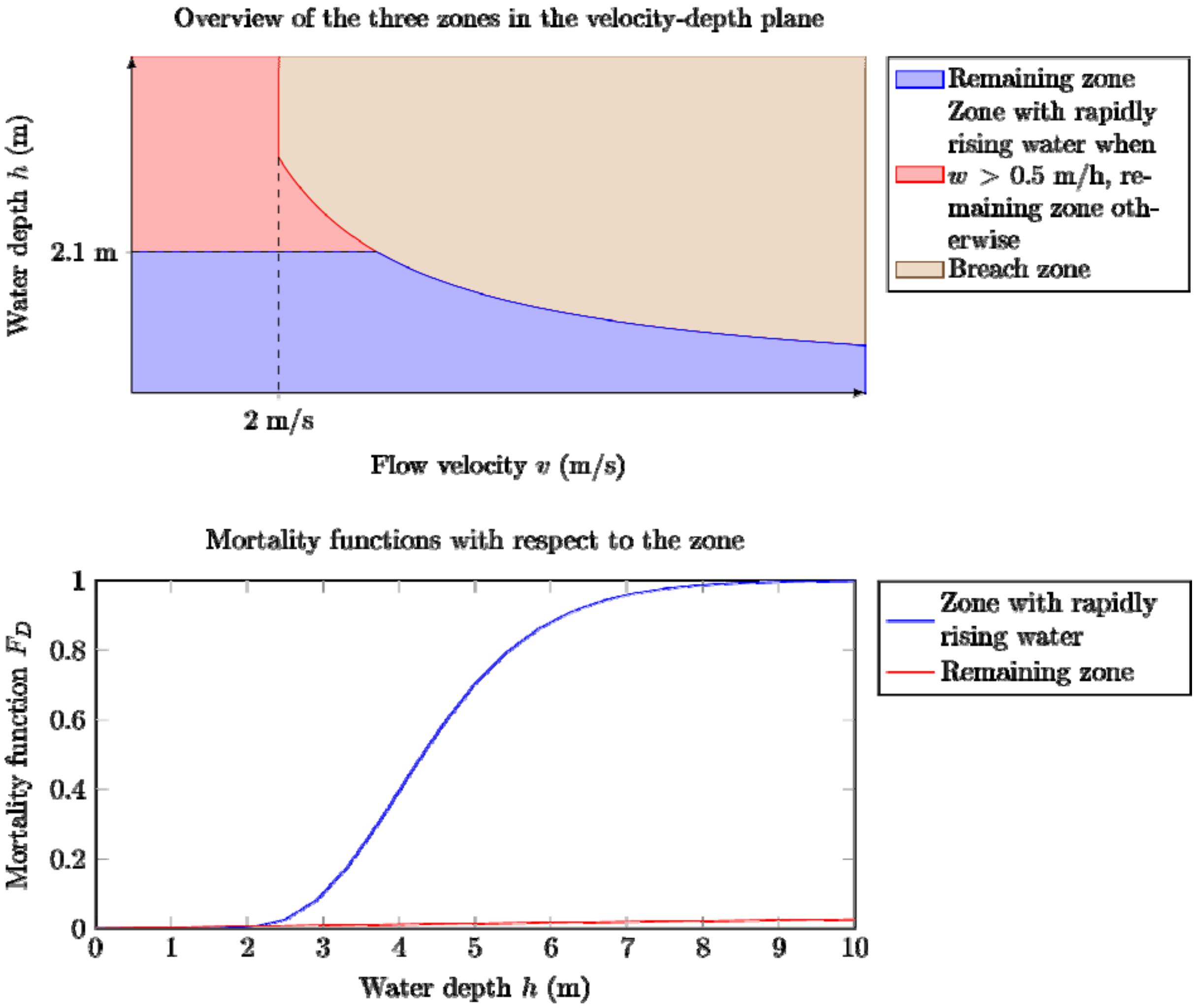


Figure 34: Mortality functions according to Jonkman et al. (2008).

To make the reading of the danger maps easier, one can choose to distinguish between several discrete categories of danger. For storm surge risk, one such categorization would be the following:

- zone a: breach zone (with hv ≥ 7 m2/s) ;
- zone b: maximal water height h ≥ 1 m ;
- zone c: maximal water height 0.5 m ≤ h < 1 m ;
- zone d: maximal water height 0.25 m ≤ h < 0.5 m ;
- zone e: maximal water height h < 0.25 m.

When considering flood risk, it is interesting to distinguish areas where the expected water depth is higher than 25 centimeters. This is indeed the height of the cars exhausters. If the water depth is over this threshold, non-floating rescue vehicles will not be able to travel in the area and the authorities have to plan the uses of boats or airborne vehicles.

Getting information about vulnerabilities At the same time, buildings have to be sorted according to their usage: residential, industrial, commercial, and specific buildings that have to be considered individually in the evacuation plan. Residential buildings will be the starting location of the population to evacuate. Industries have to be identified especially if they are particularly vulnerable to the foreseen disaster and if the lack of action is bound to cause a secondary disaster. Commercial places are also interesting at later stages, when evacuees have already reached the shelters, and when the authorities have to provide people with food and water. Specific buildings include the following categories: hospitals, prisons, police stations, child care centers, schools at different levels, nursing homes, universities, hotels, campsites. They should allow to identify vulnerable groups in the population and dependants.

By intersecting the hazard maps with the buildings usage maps, one should then get a map of the priority evacuation sectors. Those are places where the water depth is expected to be high enough to threaten the population and at the same time with a high density and especially a large number of vulnerable persons. Categorization has to be fine-tuned according to the configuration of the city, the expected intensity of the event and the level of preparedness of the population. Too few categories will not provide any information to the decision maker, while too many will make the map unreadable. A total number of six or seven categories is usually a good trade-off. Several maps can be drawn at this stage, one for each type of building, where the color of the building reflects its level of danger.

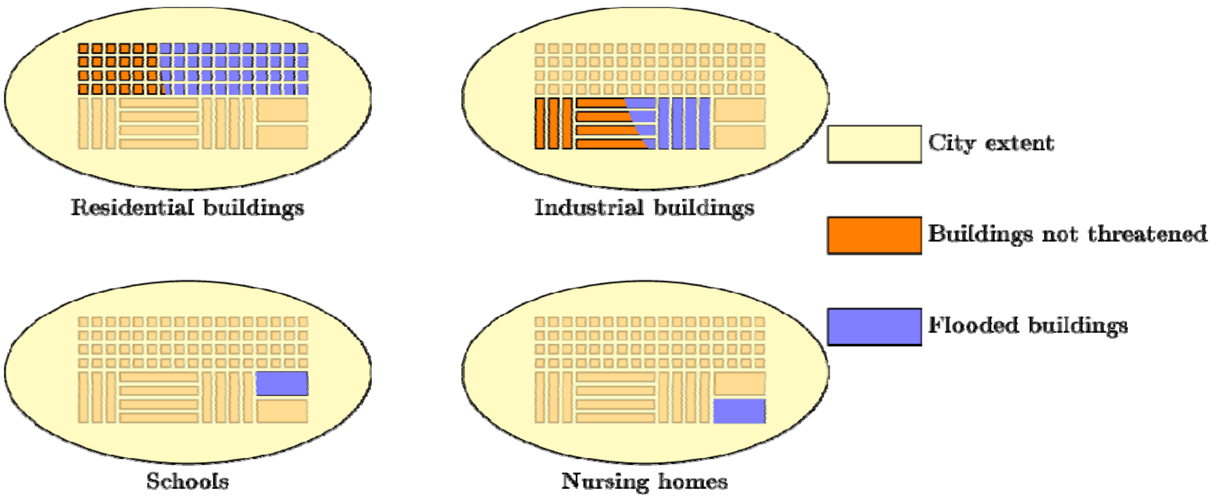
Among the buildings identified here, some may also be used as shelters for evacuees. In some circumstances, the lower floors of the buildings may have a high level of danger while the higher ones remain safe. This happens especially for slow and short floods where people can seek shelters at the top of higher buildings. Characteristics of acceptable shelters are defined further in 5.5.3 page 101.

A major difficulty here is to determine the location of the inhabitants at different periods of the day. Indeed people move around in the city during the day and the actual density of population changes a lot. However, when a strong event is foreseen and the population is warned, one can expect people to come back home as soon as possible. Some will try to get their children and families with them, others will want to fetch personal things. Under the assumption defined earlier that the event is predicted 24 hours before it happens, the time needed for the people to go back home (as the sum of the warning acceptance factor and the warning lag factor) can be taken into account in the methodology. In the first two or three hours, one can consider that people will not start to evacuate. When those movements are over, the methodology can be applied by considering everyone starts to evacuate from his own home.

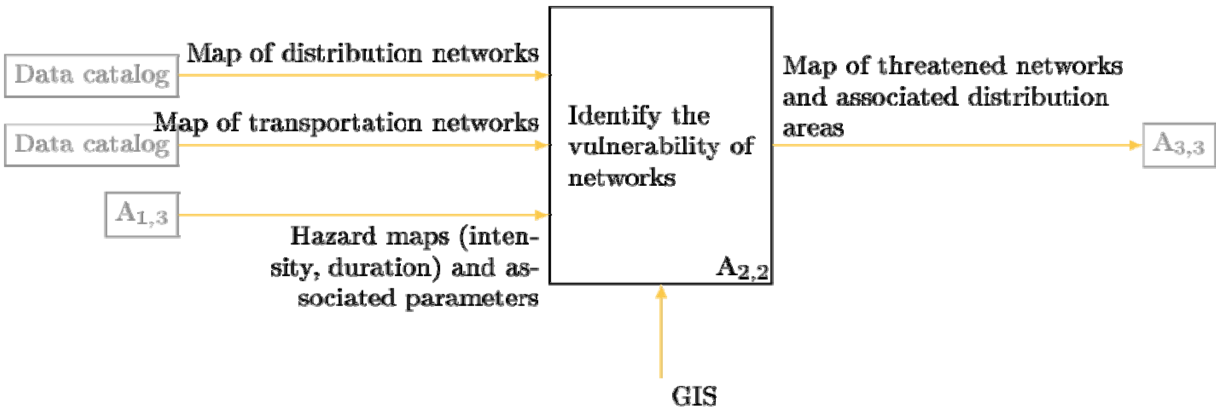
This stage is quite crucial because it tackles three major issues of the preparation of an evacuation plan (as defined by 4.1.2):

- where will an evacuation be necessary?
- under which conditions can the authorities support people sheltering in place?
- where are the vulnerable groups located?

Example:



Identify the vulnerability of networks



Networks, whether transportation or distribution ones, play a critical role in the emergency chain. Transportation networks (roads, railways, subways, airways, waterways) are used by people to leave the threatened area and go to a shelter. Distribution networks are fundamental elements that have to be taken into consideration when assessing the safety of buildings. It must not be forgotten that even if a part of the network is not in the threatened area, it may still be out-of-order if all its connections to the sources are cut. For all those reasons, one should carefully identify the parts of the network that may be disrupted by the different hazard scenarios.

Transportation networks For each transportation network that may be used by evacuation vehicles and every hazard scenarios, the evacuation planner should draw a map of the exposed part by crossing the map of the network with the hazard map for the given scenario. A threshold has to be defined so that, when the intensity of the disaster is greater than it, one can consider the vehicles will not be able to drive on the network. For road networks during a flood event, this threshold may be defined as the height over the ground of the car exhausters. It may vary a little between countries but it can usually be set at 20 centimeters for common vehicles and 25 centimeters for rescue vehicles. In the case of a wind event, four-wheels vehicles start to be hindered by wind which speed reaches 43 m/s (Schmidlin, 2003): a reasonable threshold taking into account a safety level would therefore be 35 m/s.

Subways are not affected by wind hazards, but particularly vulnerable to flood hazards. Since tunnels under the level of the groundwater level during flood are never fully waterproof, pumping systems should supplement the protections. If the capacities of those systems is suspected to be exceeded, one should consider that all the lines that have at least one part in the exposed area will be disrupted.

Trams and trains are vulnerable to wind hazards in the same way as trucks: wind speeds should not exceed 35 m/s so that trains are not tipped by the wind force. As far as flood are concerned, the situation depends a lot on the type of power supply. Newest trams are built with a groundlevel power supply, which will always be disrupted in case of a flood, no matter the height of water. With aerial power supply, trains can still circulate if the water level is not high enough to lift them off the ground, that is when the water level does not exceed the height of the side skirts (taking into account a safety level), which is about 30 centimeters above the ground.

Airborne vehicles are not hindered by flood except when the airport is submerged. However, they are very vulnerable to wind. The decision to operate a plane relies on the plane company. Generally they decide to stop their operations when the wind speed exceeds 35 knots or 18 m/s. However, natural hazards often go together with bad weather conditions (clouds, storms, fog) that can also prevent the plane from taking off. Helicopters can fly with wind speeds up to about 10 m/s.

Finally, in the case of a flood disaster, boats may be the only reliable option to convey people and equipment. They can be used when the water velocity is not too high. The water depth should at least be equal to twice the draught.

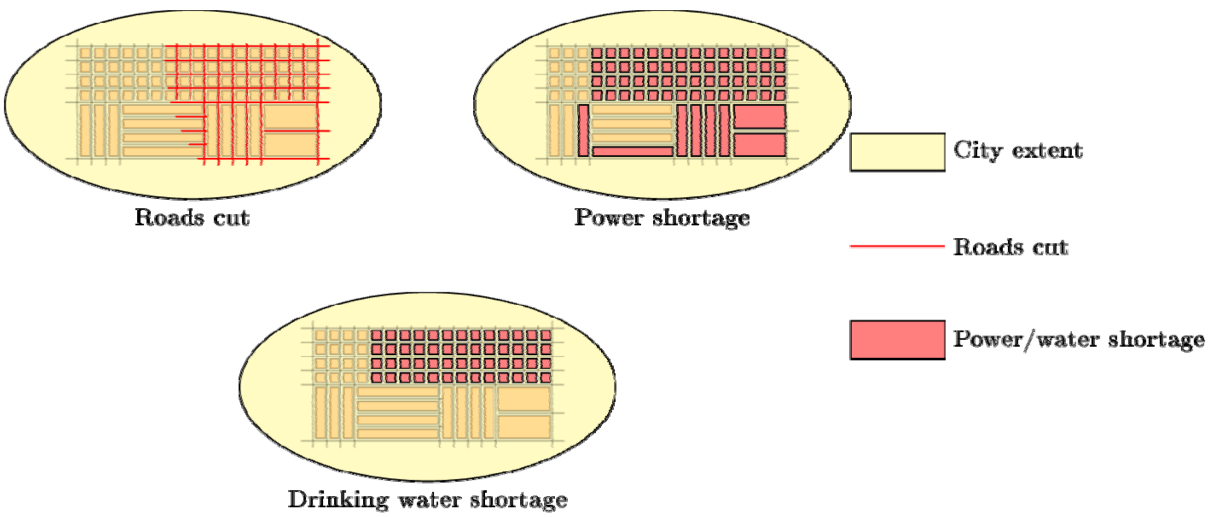
Distribution networks A careful assessment of the disruption of distribution networks can only be done by working together with the operators of those distribution networks. According to their procedures of operation, they will be able to deduce the disrupted area from the exposed one. Contracts can be concluded with them so that some priority areas are served during the disaster at the expense of other less important areas.

For the electricity and gas networks, one should take into account the location of lines (underground or aerial). Underground lines are generally less vulnerable to all kind of hazards. However, even if they are well isolated from the ground, one can expect disruptions when the flood lasts for several hours or days. Aerial wires may be damaged by strong winds, especially if their forces are sufficient to lift off and carry small objects.

Drinking water networks can also easily be disrupted during floods. The main problem does not come from the pipes being broken, but from the decontamination plants which can not deal with too high water quantities. This situation happens especially when the flood results from large amounts of rain.

The identification of potential power and drinking water shortage is especially important for buildings that are to be used as shelters. If a power shortage is expected, one should provide the shelter with autonomous power generation. Drinking water is very likely to get disrupted during the flood and therefore a good practice is to store bottles of water at those places. One should count at least two liters of water per person that will be accomodated in the shelter and per day. Storing water for two days will make sufficient time for the authorities to plan new supplying.

Example:



Networks disruption for the 100-year flood

Power shortage
According to the electricity company, a 100-year flood is likely to disrupt the electricity network because some of the wires north-west of the city are still aerial and their support pylons may get swept away by the stream. The technical services will need at least 2 days to restore power once they get safe access to the area. Three industrial buildings depend strongly on the power supply and have their own supply network directly connected to transformers by safe buried wires. They should not suffer any power shortage.

Water supply
Residential districts north-west of the city are supplied by a water pumping station which operation will be stopped before the disaster to prevent further damages. They will not have access to drinking water as long as the pumping station is flooded, that is during 24 hours for the 100-year flood.

IDENTIFY ACTION LEVERS AND OTHER STRATEGIC DATA

The aim of this part is to describe the potential resources that can be summoned to facilitate the evacuation process: human resources, material resources, shelters, transportation means, actions levers that will speed up one of the stages of the process. Those data are independent of the hazard to a large extent, although some specific resources may only be used for a particular type of hazard. (For instance, pumps are only useful in case of flood.) Thus, most of this section only has to be done once for all the hazard scenarios. Shelters however still have to be identified for each hazard scenario because different ones must be used according to the type of risk and its intensity.

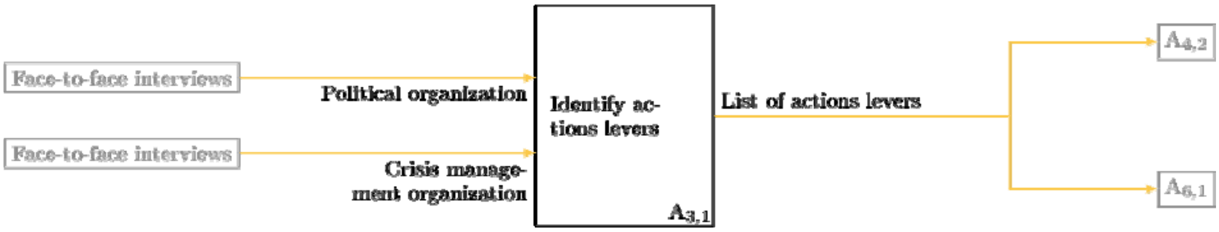
On the other hand, most resources that will be described here are not the own property of the emergency services or the state. To ensure their availability at crisis time, as mentioned in 5.1.3, one should consider establishing contracts with the organisms or individuals responsible for the resources.

Actions levers are the strategic decisions that can be taken by the authorities in charge of managing the emergency and which can help the evacuation happen faster. They refer to several fields:

- communication to the population to reduce the warning acceptance factor and warning lag factor, make them leave their home faster and feel more confident toward the advices of the authorities ;
- facilitating transport in the city by changing the directions of some roads or closing others ;
- providing assisted evacuees with vehicles to help them leave the threatened area ;
- assisting evacuees when they are still on the roads or already in shelters ;
- …

At the end of this part, one should have a list of shelters that can accommodate evacuees, a list of temporary transfer structures, and a global capacity of all resources and transportation infrastructures.

Identify actions levers



At this stage, the planner has to use his knowledge of the emergency management organization to evaluate the room for manoeuvre of the organism which is preparing the evacuation plan. This part does not require much data but need a very strong cooperation which is sometimes difficult to achieve. It is important to identify the decisions the emergency management authority can take by itself and the ones that involve other role-players, either private companies or public organisms at a higher level. When an action is considered as important for the evacuation process, if its implementation requires the cooperation of many organisms, it has to be written down formally in a contract between the planning authority and the third-party companies.

It is generally a good idea to start by identifying all the organisms that could be involved in the process and to invite them to a meeting as well as some actions that can improve the evacuation. During the meeting, the planner has to present the results of the two first stages of his work, and especially the hazard scenarios and the maps of the vulnerabilities. He can then suggest different strategies that will be discussed and adapted based on the constraints and requests of the other organism.

The aim of this part is to produce a list of measures that the authorities can take before or during the crisis to improve and speed up the evacuation process. Examples of such measures are described below but other actions can be taken depending on the prerogatives of the authority and the contracts that have been concluded with other companies.

Transport Some of the following actions levers can usually be used by the authorities to help the evacuation take place as well and fast as possible:

- Setting up contraflow lanes
    - This consists in reversing the directions of some roads or even fully closing roads to make the road network as effective as possible to let people leave the threatened area (see Figure 35 below). The rythms of traffic lights should of course be altered accordingly. Yet one should not forget that opening new lanes for the outgoing traffic will not magically increase the network's capacity and speed up the evacuation process. An unconditional reverse of all roads in favor of the outgoing traffic is even likely to raise more issues than it solves, with unexpected congestions occuring at crossroads where

several outgoing roads are crossing and the priorities of the traffic do not match the actual discharge of roads. Furthermore, changing the whole transport plan will puzzle people who are used to their common itinerary and cause many accidents. This method is also quite difficult to implement because contraflow lanes usually lack signage, signals and traffic control devices. The logistics of setting up road blocks, diversions, signage, and ensuring the inbound lanes are free of traffic is extremely time-consuming and requires a lot of people. Therefore, contraflow lanes will only seldom be set up in urban areas.

Figure 35: Contraflow lane reversal in use during Hurricane Rita

If the authorities do still want to implement this option, the location of contraflow lanes, the duration of the altered transport plan, and the accompanying measures have to be carefully planned long before the disaster, when the evacuation plan is being written. A traffic flow model can help assess the impacts of the contraflow lanes on the times needed to evacuate the threatened area. The evacuation plan has to describe accurately the following elements:

- the location of contraflow lanes and especially the points where they will join normal lanes,
- traffic diversions that are induced by those contraflow lanes,

- the number of persons needed to make sure the new transport plan is respected and to help and direct people in their cars to the right direction (some people are needed at every entrance, exit and crossover of a contraflow lane),
- the additional equipment that has to be prepared (signage, road blocks),
- the time needed to prepare the change in the traffic plan,
- the benefits of the measure in terms of time to evacuate and security of people.

- Planning evacuation routes

  Itineraries dedicated to evacuations help to share the traffic load on the network by assigning directions to drivers based on their origins, their destinations and the current traffic of the network. The purpose is to use the network in a nearly-optimal way. Two options are available:

  - A static planning, where inhabitants from different districts are assigned different exit points and routes during the planning phase. This approach requires the least amount of work during the crisis but a significant communication work should be done beforehand so that most people are aware of the itinerary they are assigned, and it is in everyone's interest to observe the instructions. Targeted communication may also help to remind people of those instructions during the crisis.
  - A dynamic planning, in which policemen direct people at crossovers and control traffic flows. The officers are able to communicate with their headquarters which provide them with new instructions regularly based on the current state of traffic in the whole town. This approach is the most efficient but requires more people to implement it and a previous installation of some systems to monitor traffic in the town (cameras, counting devices…).

- Use of public transportation

  The use of public transportation is a major actions levers for authorities because it can drastically reduce the traffic load on the road networks. Busses, trolley busses, subways, trains can be used provided that the resources available during the crisis are well known and that contracts have been signed with their owners during the planning stage. Public transportation will at least be the only option for assisted evacuees.

Communication Communication is at least as important as transport because it makes people aware of the threat and makes them leave their home earlier. People on the roads who know the danger and the way to behave to keep safe are less likely to panic. Authorities have many ways to communicate informations to the public:

- Radio

  Radio remains the most efficient way to reach the whole population with a single message. Contracts can be signed with public or private radio operators so that official messages can be broadcasted regularly or at will during the crisis. In some countries, an association groups many radio operators and proposes arrangements to broadcast the messages on all their frequencies.

- Television

  Since most people are equipped with a television, one could think television is a good way to communicate information, all the more so as visual messages raise awareness of the threat a lot better than audio messages. However, people will watch at it only during the first hours after the warning. As soon as they prepare to leave or are on the roads, they will not have access any longer to this media. So television must be seen as a secondary medium.

- Door-knocking

  Experience has shown that door knocking conducted by emergency services is the most effective method to issue warning (Keys and Opper, 2002). Messages can only be sent at the very start of the evacuation process. After that, people may not be at home any longer. It requires however a lot of resource and it is very slow in delivery. Experiments in real towns show that the average rate of door knocking to deliver the warning is 12 houses per hour per team. Considering a team should consist of two persons and the average size of a family is three persons, each emergency service officer will deliver the message to 18 persons per hour. For large-scale evacuations of districts with several tens of thousands of inhabitants, this solution is not applicable as it would require too many door-knocking officers or too much time. Door-knocking is best used as a method of sending the evacuation order in small cities or when threatened people do not have access to other media. According to (Ministry of civil defence, 2008), doorknockers should wear a uniform to be clearly identified as members of an emergency service, say a message from a prepared script and distribute papers with additional information to residents.

- Sirens

  Sirens can be used to issue an evacuation order. Its content is contained in a sequence of pips with different durations. There should be repeated communications so that people understand the meaning of the signal. Sirens are usually managed by fire brigades.

- Loudspeakers

  Some cities have a public loudspeaker network that they can use to disseminate a message during the crisis. If it is not available, vehicles fitted with loudspeakers can drive across the city and broadcast a message. Loudspeakers are best used to issue the evacuation order with some advices about how to behave. Messages must be short so that they can be repeated often. Fire brigades and town services may have such vehicles.

- Internet

  Longer messages can be sent out by email or over a website. A website is easy to maintain and does only require minimal resources. It can provide up-to-date information about the state of the territory and advices from the authorities (shelters, evacuation routes, gathering places for public transportation…). There is virtually no limit to the size of the message. Citizens have to be informed of the existence of such a website and the address should be easy enough to be remembered. The drawback is that many people can not connect to the Internet, especially when they are outside. Mobile phones start to be able to connect to the Internet but this tool is still only available to a small part of the population. In a few years, this channel will be more suitable for crisis communication. Emails are as fast as the update of a website and their benefit is that they can convey custom messages to individual people. However this requires the maintenance of a mailing list of all inhabitants, which is quite difficult to achieve.

- Automated phone calls

  Some municipalities are equipped with devices that can phone to a list of recipients based on a phone directory and deliver each time the same message. Some tools can select the message based on the location of the recipient. When the phone call has succeeded, the database is updated so that a map of failed phone calls is automatically drawn. This method of communication is very efficient and quite fast for it can delivers about 60 000 30-seconds messages per hour. Different orders and advices can be issued to different districts. The only drawback of this method is its heavy reliance on the phone network. Decision makers should always prepare to communicate over a secondary channel in case this one is down.

- Cell broadcasting

  This system is very similar to the previous one. It allows to send the same message to all mobile phones in a specific area (a cell of the network). The message can therefore be customized according to the actual location of the cell phone's owner. The broadcasting technology avoids the overloading of the network. Once again, this technology relies heavily on the GSM channel and a secondary channel is needed in case the network is down.

- Matrix signs / changeable message boards

  When the evacuation has started and people are in their cars, it may be difficult to send them new messages. Changeable message boards above motorways can deliver small messages, mostly to inform about traffic conditions and to redirect people to less-used roads;

Table 14 : advantages and drawbacks of each communication medium.

Communication media	Benefits	Drawbacks
Door-knocking	Good persuasion rate	Needs a lot of time and staff, not applicable on a large sector
Loudspeakers	Fast implementation, covers the whole city	Message can be hard to hear and not clear
Medias (TV, radio, newspapers)	TV and radio are the most efficient means, real-time communication	Can't be used if the electricity is cut (but should not occur before the event), newspapers are too slow
Amateur radio	Proximity to shelters, information about the decisions of authorities	Need a confirmation by authorities
Automated phone calls	Direct information with specific advices, no staff required	The function must be activated. Authorities must maintain lists of phone numbers
Internet	Freedom of size and content of messages	Need an Internet connection, network may be disrupted
Changeable message boards	Real-time information, directly visible by cars	Need to find strategic places
Sirens	Heard by the whole population	Limited information about the risk and how to behave

Past studies show that people trust a message more when it is delivered by relatives and that they mostly get their information from one preferred channel. Furthermore some networks may be down during a disaster. So one should try to disseminate the message through as many channels as possible.

Example:

Actions levers available

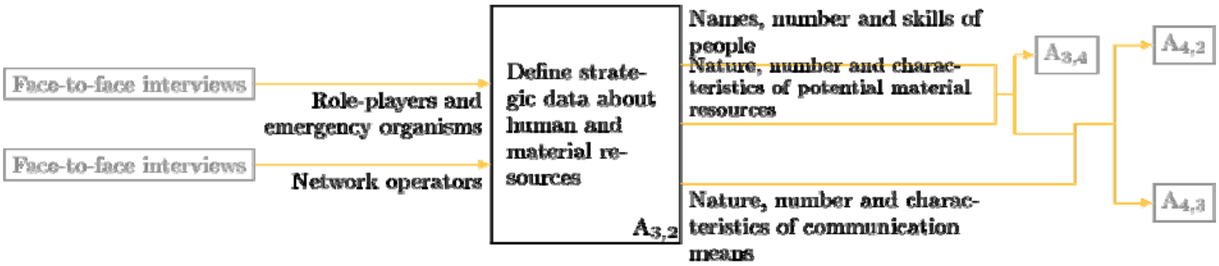
Transport

- Alter the urban transport plan and switch to the emergency urban transport plan
- Send 2 policemen at every crossroad of the "Bayview" district to direct people to the neighbouring towns
- Call up busses from company "Seaside travels"
- Call up transport trucks from the military regiment of "Toughguys"

Communication

- Send a prepared text to all changeable message boards on the motorways to indicate evacuation routes
- Deliver automatic phone calls to all people of district "Bayview" to tell them to evacuate before one hour and go to the neighbouring towns
- Send 20 teams of people to knock doors of old people's houses to make sure they got the warning and evacuation order

Define strategic data related to human and material resources



Actions levers previouly identified usually need complementary human or material resources to be pulled. The aim of this part is to identify those human and material resources that could be called up to facilitate an evacuation process. As said previously, one can only consider a resource is available if a contract has been signed with its owner or responsible organism so that it may be requisitioned when needed. At this stage, the purpose is only to identify all available resources. Later on, a choice will be made to select the resources that are the most adapted to the situation. Finally, the actual availability of the selected resources will be addressed in the last part of the methodology.

The data catalog makes an inventory of all resources that are available on the territory and can be used for emergency management. From this inventory, an additional work has to be carried out with surveys of the involved organisms to describe precisely which means can actually be used during the crisis. Those surveys shall tackle private companies and voluntary associations in priority, whose resources are not well known. For public organisms, it is advised that the emergency services maintain an up-to-date list of all resources. The survey should also identify which resources or staff can be made available during the crisis, in a reasonable amount of time. This information is very important to coordinate the actions of the organisms during the crisis. The emergency response unit should gather representatives of the main organisms providing resources so that decisions can be made as fast as possible with the right entries at a relevant level to the different institutions.

Human resources include not only specialized staff but also experts on a particular field who may offer their help during a crisis without being official members of the emergency response unit because they will only be called for precise questions. For instance, if a town is faced to a strong industrial hazard due to a potential spill of chemical pollutants, it should be able to call experts on chemicals during the crisis to understand the effects on the environment, on human health or the expected outcomes of a chemical reaction with another component. Of course, most of this analysis should already be done before the crisis and detailled in an appendix of the emergency management plan. The role of the expert is to supplement the analysis when something happens that was not foreseen. For natural hazards, one may conclude agreements with some experts in protection structures (to assess the state of the protections and decide if and which maintenance actions have to be taken), hydraulic engineers, meteorologists (to foresee the evolution of the disaster on the field), geologists (to evaluate the risk of landslides)…

Example:

Human and material resources that can be engaged during a crisis

Organisms involved in emergency management

- Fire brigade of town A
- Fire brigade of town B
- Emergency ambulance service
- Voluntary civil protection association CivilPro
- Hospital Percy
- Town police

For each of these organisms, the following questionnaire has been filled.

Fire brigade of town A

Organism	Contact person(s)	Telephone	Mail	Address
Fire brigade	John Doe	555.3445	john.doe@mail.com	John Doe, head of fire brigade, A

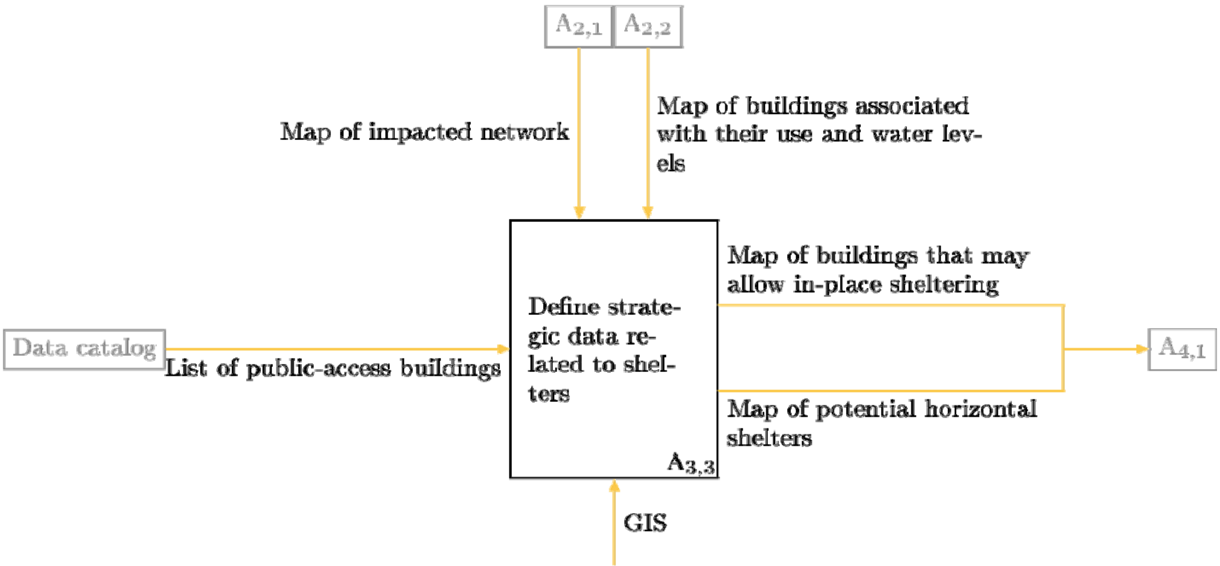
Material resources	Nature	Location	Capacity	Number / *amount*	Availability
Linens		North rescue center		1000	On request, ready in 24 hours
Beds		South rescue center		500	On request, ready in 24 hours
Rescue packages		Main center	10 people	20	On request except on winter (maintenance) and during external operations, ready in 4 hours

Continuing on next page

Example (continued from previous page):

Specialized cells	Field hospitals	Main center	100 persons	1	Ready in 24 hours
	Decontamination cells			0	
	Mobile headquarters			0	
	Rescue and clearing cells	South and main centers		2	On request, ready in 24 hours
	Other				
Vehicles	Sanitary			0	
	Transport of people		50 seats, 20 standing	20 busses	Immediatly
	Mobile headquarters			0	
	Transport of material			0	
	Other				
Communication, signals	Radio antennas Road signs Barriers Other		10 meters	200	Immediatly
Human resources	Contact	Location	Specific skills	Staff	Availability
Rescue teams	Jane Doe	Main center	First aid, nuclear decontamination	20 people in 2 teams	On request, ready in 2 hours
Drivers					
Chemical experts					
Protection structures experts	M. Field, USACE	5th avenue, New-York	Specialist on dikes	1	Contract signed, ready in 2 days

Define strategic data related to shelter



In the same way as the resources for emergency management were identified at the previous stage, the planner now has to locate all buildings which could be used as shelters for evacuees. This identification stage must be completed with the organizations that manage the potential shelters (public education authority, health department…). Different options have to be considered: in-place sheltering, public shelters, housing by relatives, accommodation in hotels. Those options may also be combined depending on the level of danger in different areas. Four broad issues need to be addressed during this stage (Ministry of civil defence, 2008):

- registration of people in shelters,
- accommodation,
- public health,
- recovery centres.

When all shelters are identified, they can be shown on a map together with their capacities and the actions required to open them. To obtain a list of shelters, the authority should gather data about premises open to the public, schools, congress rooms, gymnasiums, select those which meet the requirements described below, and check their availability by intersecting their map to the risk maps.

Common requirements The following requirements have to be met by every place considered as a shelter, whether a public shelter or the inhabitants' homes (Emergency Planning College, 2006):

- the shelters must not be threatened by the disaster : this does not mean that they must be completely out of the exposed area, but their structure and functioning must not be interrupted during the event ;
- people shall have access to food and water. There must not be any disruption of the supply, even for one day. For food, provisions can be made so that food is stored in the place, at least for some days. In the case of water, authorities have to deliver water if the distribution networks are disrupted ;
- the shelters are accessible for the public, the suppliers and rescue services, in safe conditions ;
- building health and safety regulations are followed ;
- the shelters have access to at least one communication medium to get instructions from the authorities and inform them about their needs and specific problems.

The sheltering sites must be identified prior to the event. Evacuation and transportation route models have to be considered to check their acessibility. For each of those shelters, a risk assessment should be completed, taking into account the base elevation of the location and the proximity of hazardous materials. In the assessments, every building has to be considered as a whole since one weak section can jeopardize the whole integrity of the place.

For some kind of risks for which the buildings might be demolished by the event (hurricane), it is important to have them certified according to structural design criteria. Pine et al. reviews those criteria for a hurricane event in (Pine et al., 2003), which are based on standards of wind-loads-withstanding structures by ASCE (ASCE 7-88) or ANSI (ANSI A58). In the same way, clues about the vulnerability of a potential shelter to the flood can be found in civil engineering guidelines like Federal emergency management agency (1993) or Salagnac (2006). However applying too high levels of structural designs may dramatically reduce the number of potential shelters. The final decision is up to the evacuation planner. In any case, the shelters must be reviewed on a regular basis (for example once every two years when the evacuation plan is updated).

A strong requirement of all shelters is a continuous access to food, water and medicines. However at the start of the disaster, the authorities are usually too busy with urgent matters like traffic management, survey of protection structures, assistance of people in the exposed area, registrations in the shelters. To leave them more time to cope with the arrival of evacuees in shelters, a good practice is to store there non-perishable primary goods (food, water, fuel, medicines) and to regularly check the state of those goods, for instance every time the evacuation plan is updated.

When all shelters have been identified, evacuation planning should check that the following requirements of this stage are met:

- The total capacity of the shelters is sufficient to welcome all expected evacuees and accommodate them for a suitable period of time. To compute the number of evacuees, assumptions have to be made since it is impossible to know the behaviour of individuals for a particular risk. The evacuation planner should carefully plan the capacity of shelters with a security coefficient to make sure everyone can be housed in a safe place. The individual care required for each individual may be lowered a bit if the available capacity is exceeded, but only by special dispensation.

- The registration of all persons is absolutely necessary when they enter in the shelter. This allows the authority to calibrate the supply needs for the shelter and to be aware of the fate of individuals in order to give information to their relatives. Pre-established agreed registration forms should be prepared and distributed to the potential shelters.

- A centralized system has to be set up to coordinate allocation of evacuees between shelters to prevent overcrowding of one them.

- Roles of each organization involved in assisting people in shelters should be perfectly clear before the crisis and written in the evacuation plan.

Figure 36: Registration of people near shelters

In-place sheltering

As stated in Ministry of civil defence (2008), in-place sheltering is often the safest option, in particular when there has been a significant disruption to transport or when going outside could expose people to hazardous contaminants. In-place sheltering removes a great deal of the burden on the emergency manager, since the danger of bringing people on the roads is lower as is the transportation demand, and the logistics of managing public shelters is made easier. However, in Jonkman et al. (2008), the authors point out that there are still logistic arrangements to be made, though very different from those of evacuation. Consideration needs to be given to people sheltering in situ so that they do not put their lives in danger by leaving their homes to look for fresh supplies.

In order to be used as an in-place shelter, a building should meet the following criteria:

- the water level above the ground in case of flood should not be higher than 25 centimeters to allow rescue services to enter in it ;
- the building should have at least two floors so that people can seek refuge upstairs ;
- the top floor should have access to drinkwater and sanitaries ;
- there should be a way for the rescue services to reach the inhabitants (from the window or, at a last resort from the roof but only if an aerial supplying is foreseen – which may only be the case for very large buildings) ;
- distribution networks supplying the building should not be disrupted, and the building should have at least access to one power supply (electricity, gas) ;
- the duration of the disaster should be limited, the exact limit has to be defined by the decision maker but will usually not exceed five or six days.

Planning for in-place sheltering in an area does not make it any the less necessary to plan for later evacuation, especially if the disaster is found out to be more serious or longer than expected. However, using this option will decrease a lot the traffic demand on the roads during the initial evacuation phase and gives more time to the authorities to summon staff and prepare public shelters.

In areas where people are advised to shelter in place, local authorities should include in the evacuation plan provisions for distributing food and water to communities. Recovery centres can be used to that purpose and facilitate the work of public authorities, provided they are close enough to the population and offer a safe way to supply welfare to people in the vicinity.

Public sheltering When the evacuation is decided, public sheltering will be used as a last resort option for evacuees (see Emergency Planning College (2006) and (Ministry of civil defence, 2008). Most of them will first seek lodging with family and friends. Once again, this solution has to be encouraged because it removes a large burden from the authorities. And the emotional impacts of the disaster on the individuals is lower when they can stay by their relatives instead of having to register to a public shelter. Thus emergency planners have to favor this option and may consider practical arrangements that could help people find refuges with their relatives.

At a second stage, if only few people were not able to seek refuge themselves, it is often more efficient and cost-effective to send them to hotels rather than opening public shelters. As already stated, this requires that contracts and agreements were concluded between the local authorities and the hotels, so that the authorities know how many rooms are available in the vicinity and that they can easily book those rooms for the people who need them.

In addition to the common requirements described previously, public shelters should be the focus of attention of authorities because of their high concentration of people. This is also why they should be located outside the exposed area. Special care has to be taken for their preparation to welcome people.

- A secondary source of power is available at the shelter (autonomous generators).
- The area per individual should be equal to or greater than 5 m2 in the case of long-term sheltering (American Red Cross, 1992). For short-term sheltering (less than one day), by special dispensation, this requirement can be reduced to 2 m2. Those figures do not include shared space for sanitaries, kitchens, stocks of food, water and medicines, and staff equipment.
- Public shelters must have disabled access.
- Arrangements must be made to support people physically, and keep them fully informed.
- Staff in public shelters is trained in all required expertises (medical care, safety, distribution of food and water…).
- Medical and counselling assistance is set up soon.
- For long-term evacuations, shuttle services can be set up to help evacuees move around in their town for their usual occupations.
- If the mobile phone network is disrupted, free phones should be set up in shelters to let evacuees get in contact with their relatives.
- Clear signage from different part of the cities, as well as a strong communication, will help people to know where the public shelters are located and how they can join them. Near the shelters, there should be enough place for the anticipated number of vehicles that will arrive. Traffic management will help to speed up the arrival of people.
- Waste management needs of course to be arranged for shelters that welcome a large number of evacuees.
- Local health care facilities must be identified for large-scale long-term evacuations and may be supported by public authorities.

One can assume that many evacuees will arrive at the shelters with their pets. Those should not be accommodated at the same place as people, but reasonable arrangements must be taken to house them at a place where their owners can see them. Only companion animals for disabled people can be admitted in the main area.

Example:

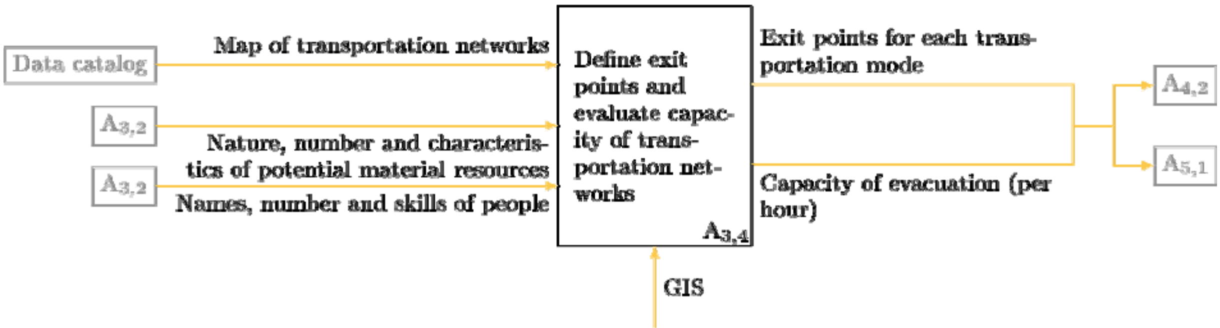
Map of the potential shelters

Shelters

Facilities and capacities

Name	Location	Contact	Capacities	Staff	Special facilities
College of the hill	23, Hillside A	John Doe 555.4324	100 persons	4 nurses, 2 policemen, 1 psychologist, 2 cooks, 2 clerks	Medical care, pets allowed
Congress hall	45, Mulholland drive	Jane Doe – 555.4325	800 persons	20 nurses, 2 policemen, 2 psychologists, 4 cooks, 14 clerks	Assistance to dependants, autonomous power generator, parking lots
City gymnasium	23, Pennsylvania Str	Bob Doe – 555.4326	200 persons	1 doctor, 12 nurses, 2 cooks, 10 clerks	No special facility apart from registration, housing and food supply, only to be used as additional shelter if others are fully booked

Define exit points and evaluate the capacity of transportation networks to evacuate the population



In this part, the planner is going to evaluate the total capacity of the transportation networks or in other terms the number of persons that can be evacuated from an area in one hour. This needs to identify at first the main roads through which the evacuation is going to take place. Exit points are critical parts of the transportation networks since they will concentrate all the outbound traffic. They are the points where congestion is most likely to occur.

Having a good understanding of the capacity of strategic routes is a critical point of the planning process. When this has been made, the planner should look at potential choke points and propose measures to reduce traffic jams there.

General considerations In a general way, planning should discourage people from using private vehicles which are more likely to cause traffic jams. Also people should be informed not to bring large luggages with them.

As already stated, practical arrangements should be made with public transport companies so that workers can be called upon to operate the vehicles. Those arrangements may involve a payment to the companies by the authorities.

Public transportation on dedicated networks For each kind of public transportation network that may be used for evacuation (subway, train, urban train), the planner has to identify the lines which will be used. This has to be made by intersecting the map of the lines with those of the expected risks according to the scenario under consideration. Exit points are at the intersection of the borders of both domains. To facilitate the process, only main exit points can be considered. The starting points of the trip are chosen inside the exposed area, close to the center if the exposed area is small enough, otherwise there may be more than one starting points.

The manager of the network should then be able to define, for each identified trip, a maximal frequence of trips, taking into account the difficulties related to a high number of people using the vehicle. This allows the planner to calculate the number of persons who can be evacuated in one hour and the total numbers of persons who can be evacuated before the disaster strikes the city.

Public transportation on roads Busses are a common and convenient way to evacuate people. The population will be ordered to gather at a meeting point accessible and easy to locate, where they will board on busses. They will bring them to safe places outside the exposed area. Knowing the starting point of the trip and the place people get off the busses, the path of the trip can be drawn and an estimated time for the two-ways trip can be computed, including the time needed to board and get off the busses.

Road network The road network will be the main vector of the evacuation. It is crucial to estimate the capacity of each lane which is planned to be used during the evacuation, and especially at the exit points where the traffic jams may be concentrated, but this is a difficult task because of the uncertainties about the actual discharges of the roads.

The maximal discharge of a road can be estimated through the following equation:

$$n = \frac{\alpha v}{L + Tv}$$

with v the average speed on the road when the limit capacity is obtained, L the average length of a vehicle (about 4 meters), T the average safety time that a driver allows to the car ahead (about 1.5 seconds), α the average occupancy of cars (about 1.4 in normal conditions, about 2 during an evacuation), and n the maximal discharge of the road.

Some more elaborate formulas for calculating the capacity of a road can be found in Highway capacity manual.

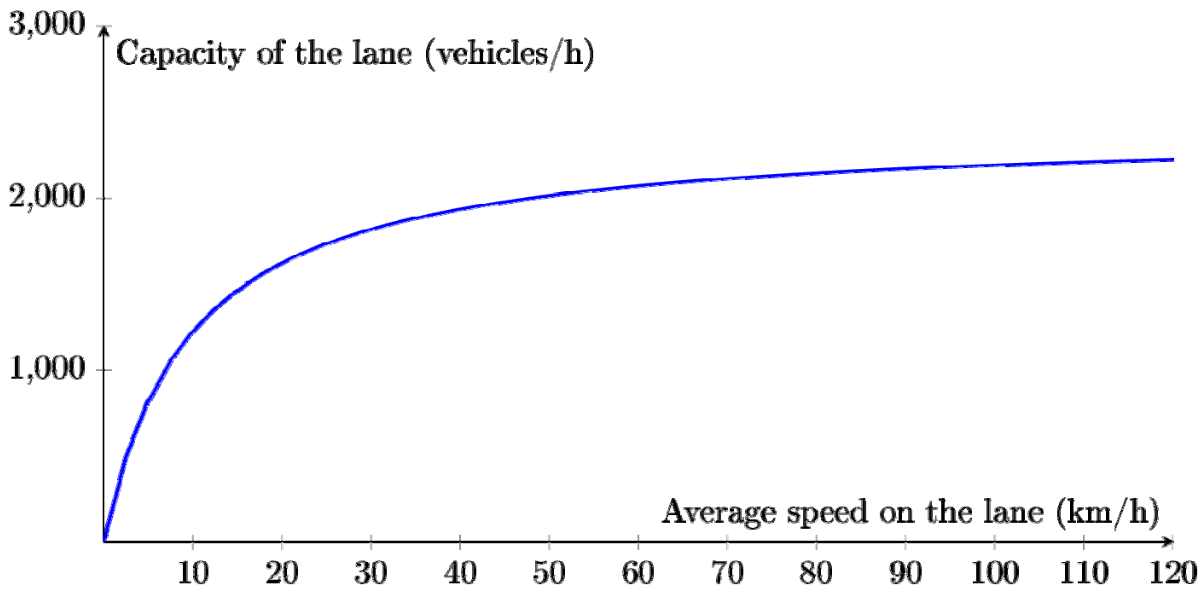


Figure 37: Average capacity of a lane in relation to the average actual speed on the lane

The figure above represents the average capacity of a lane based on the average speed of vehicles of this lane, for small vehicles. Under normal circumstances, the average speed of traffic in an urban area is between 15 km/h and 20 km/h. This leads to an average discharge of urban roads of about 1500 vehicles per lane and per hour. However, during an evacuation, the average speed should be divided by 2 or more to take into account adverse driving conditions, traffic accidents or the consequences of a bad weather. Different figures are proposed for the capacity to take into consideration during an evacuation process (see an example on table 15 below).

Table 15: Capacities of lanes during an evacuation (Ministry of civil defence, 2008).

Road type	Capacity (vehicles/lane/hour)
Motorway	1200
Rural	1000
Urban	500

The numbers of vehicles on the preceding figure and table actually stand for an equivalent number of light transport unit. Since busses or trucks are longer than individual cars, the discharge of the road will not be the same if the traffic contains a high number of those. Each vehicle is therefore associated with an equivalent transport unit value. Individual vehicles have a value of 1 whereas busses or trucks usually accounts for 2 equivalent transport units.

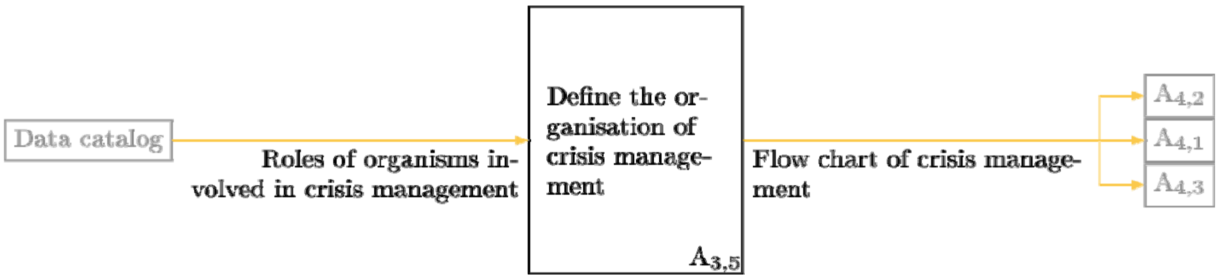
This method allows to estimate the capacity of the roads and the number of persons who can be evacuated per hour. For more accurate results, it is advised to use a traffic simulation model and to calibrate it with the actual trips that are expected from the population in the exposed area.

Example:

Exit points and their capacities

Transport network	Exit points	Estimated capacity (persons/hour)
Road	I44 - north west	5000
	I45 - south west	2000
	Park avenue outbound	800
	Dominic street	500
Train	San Pedro – Rio Grande	8000
	City line B	3000

Define the organisation of crisis management



A successful evacuation requires a good coordination between different agencies. This process is particularly difficult because of the number of institutions that are involved. To facilitate the procedures, the crisis should first be managed locally, as close to the event as possible. Although the organisation of crisis management may already be described in rules and regulations, it is always useful to remind the roles of everyone in the evacuation plan. At least, the plan should describe the organisation and functioning of the emergency response unit.

Emergency response unit The emergency response unit gathers representatives from the main organisms involved in crisis management: police, fire and rescue services, ambulance services, local authorities, voluntary and community sector, health department, environment agency, highways agency, main transport and distribution companies. The composition of the emergency response unit is written in the evacuation plan. As soon as the event is known, it is called together. Its procedures of operating should be well defined and the staff trained before the event. Among those procedures, the following aspects have to be taken into consideration:

- The emergency response unit has access to the evacuation plan and all other emergency plans as soon as it is created.
- The unit has phonebooks with the names and phone numbers of all persons or institutions which may have a role in the emergency management.
- Rooms are dedicated to the different cells. Each room has screens and computers available for the member of the unit.
- Every inbound communications and actions that are taken are registered on a special form.
- The unit has accurate maps of the territory it has to manage.
- The emergency response unit shall be splitted in four cells (Lagadec, 1995), located in different rooms but with strong interactions between them:

Supervision cell:

- it is responsible for the management of operations and defines the general strategy. It is directly in relation with the person in charge of managing the crisis.

Management cell:

- this cell brings a strategic help to people on the field and addresses the different problems in their complexity. It prepares response strategies and presents them to the supervision cell. The person responsible for this cell is usually called the "crisis director". He will be the spokesman of the emergency response unit for press communications, except for the most important ones.

Communication cell:

- it is in charge of the relations with the media and the public. It let the other cells know the requests for information from outside and prepares the communication messages.

Logistics cell:

- its role is to make sure the other cells have the technical means to fulfill their assignments.

The representatives of third-party organisms involved in crisis management are assigned to the management cell. Their role is to facilitate the exchange of information between the authorities and their organism thanks to their good understanding of the assignments and organisation of it.

It is vital that the emergency response unit is able to communicate with rescue services on the field. Its communication media should therefore be duplicated, using different channels (phone, mobile phone, Internet, secured network) to make sure one at least is operational during the crisis.

Organisms involved For each organism involved in the emergency response (public organism or private company under a contract with the authorities), the plan should define its role. The main roleplayers in a case of mass evacuation are (Beaulieu et Marchand, 2001):

The city and metropolitan area services

- are the first involved in emergency situations due to their proximity. The role of the authority depends on the regulations. The mayor often has the responsibility for the evacuation in his city and can delegate its management on a director of technical services. All other services may be asked to provide advices about the evacuation process. The town is also usually responsible for communication to the public, and especially giving instructions about the way to behave.

Other cities

- in the vicinity can help by providing shelters or sending rescue staff and equipment to the exposed city, if they are not themselves in the exposed area.

The spatial planning agencies

- shall give the decision maker as many information as possible about the event and the territory where it takes place. On a regular basis, they update their databases with informations about population, buildings, and infrastructures.

The police department

- will be in charge of regulating the traffic in the city, by closing some lanes, giving directions to people, and stopping inbound traffic. It may have to disseminate the evacuation order to the citizens. After the evacuation has taken place, it has to enforce law in evacuated areas and around shelters.

The fire brigades

- have to protect people insofar as they have the material and availability to do it. During an evacuation, they will assist in disseminating the evacuation order and help dependant people to get to safe places.

The highway agencies

- give information about the state of the roads to the emergency response unit and operate road signage.

Public transport companies

- will primarily help assisted evacuees to get to safe places. They should also maintain maps of the networks, softwares to test different modes of operations.

The municipal service of recreational activities

- can help the evacuation by providing an expertise in organising and managing shelters (registration, housing, food supply…).

Food and health departments

- check that no contamination may occur from the disaster. They may also play a role in supplying evacuees in shelters with food and medicines.

Ambulance services

- will have to evacuate injured or sick people and they may have an important assignment for the evacuation of hospitals and nursing homes.

Schools

- can serve as shelters thanks to their rooms and their equipment. If this is the case, they should maintain stocks of foods and primary goods for the first days of the evacuation.

Hospitals and nursing homes

- must evaluate the impact of the disaster on the health of their patients. They have to take a particular care in the planning of their own evacuation. They have to identify all the resources that are needed in the region and prepare specific evacuation plans taking into account the dependences of their people. If they are not struck by the event, they can also provide shelters to evacuees with particular needs that can not be met in public shelters.

National or federal departments

- step in as a support to local institutions.

Voluntary organisations

- do not interfere in the decision process but their contribution to the emergency response is essential. They can act as support to local authorities or facilitate the transition between the authorities and the people. Non-governmental organisations will also act to improve the comfort of evacuees.

The armed forces

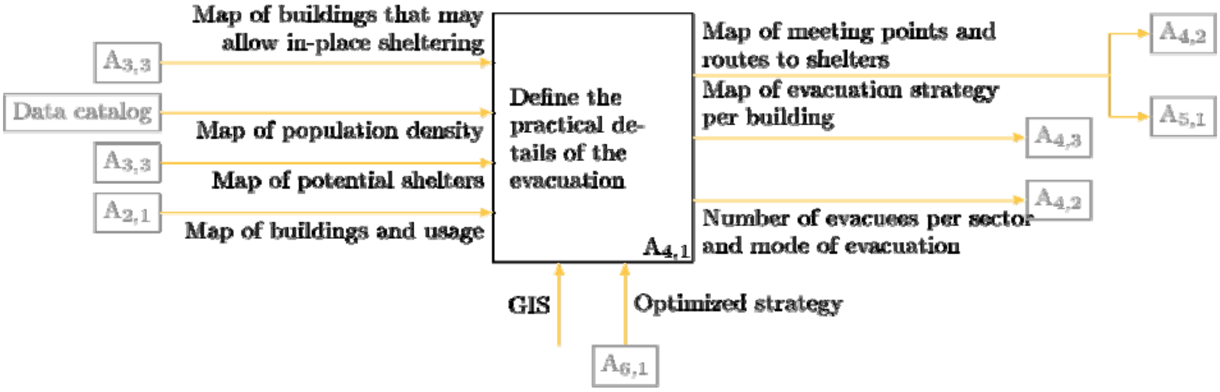
- are called upon as a last resort. One should not base plans upon their availability since providing assistance to civil operations is not an assignment of these units. However, when used appropriately, the military regiments can provide a useful help to the local forces, especially when one is located in the town or close to it.

DEFINE THE EVACUATION STRATEGY

From all data gathered in the previous parts, it is now possible to elaborate the evacuation strategy. This is made in three steps:

- First, the evacuation planner defines the practical spatial and temporal details of the evacuation. Two major stages can be identified: at first the population evacuates on its own, then a collective evacuation is organized for assisted evacuees. The two stages can overlap. Here the “evacuate” verb means that people are moving to a safe place, whether it is in-place sheltering or real evacuation to shelters.
- When this is done, the transportation options are reviewed, as well as the actions that have to be carried out to facilitate it.
- Finally the communication plan is set up based on the evacuation strategy.

Define the practical details of the evacuation



At this stage, the planner defines the overall strategy of evacuation given the information he collected in the previous parts about the hazard maps and scenarios, the vulnerability of populations and networks and the possible change of situation. The main steps are:

- define the general strategy of in-place sheltering or relocation per evacuation sector;
- define the chronology of the (horizontal) evacuation;
- define meeting points and routes to shelters for assisted evacuees;
- associate shelters with population in evacuation sectors.

Definition of the general strategy of evacuation From the map of buildings with their usage, one can select the type of evacuation that has to be made for each building. Either in-place sheltering is allowed, at least for some time at the beginning of the event, and it is encouraged; or evacuation to safe places outside the exposed area is necessary. In some cases, when the capacity of a building is sufficient to allow neighbouring population to meet in it, the planner can use a mixed strategy and suggest that people meet in the safe building close to their homes.

In-place sheltering is only advisable in areas where the hazard is low. Requirements for the buildings where in-place sheltering is allowed are pointed out above. Those are quite strong requirements, especially when we consider the fact that uncertainties and lack of knowledge about the future disaster lead to overestimate it and launch evacuations even if staying in place would be an acceptable option. Sometimes, the public authority can not check regularly if they are met by each building and will choose not to allow in-place sheltering at all to be on the safe side. Furthermore, in-place sheltering should only be encouraged if the foster building is not fully isolated during the event, so that the authorities still have a way to reach the population if needed.

All persons living in the exposed area who can not shelter in place will have to evacuate, either by their own or with the assistance of authorities.

Definition of the chronology of the evacuation A general evacuation timing model is shown on Figure 38 herebelow. This model can be used to estimate the time needed to proceed with the evacuation. To this purpose, the best is to work from the end, when the disaster strikes the town and the evacuation routes are cut off. The fact that this moment can be forecasted is one of the assumptions of the methodology. The authorities should take into account a traffic safety factor to allow for unforeseen events such as road crashes. The delays for individual and collective evacuations can be estimated through simulations taking into account the spatial configuration of the town, the road networks, and the population repartition, whereas warning lag factor and warning acceptance factor are estimated in the data collection stage thanks to interviews and surveys.

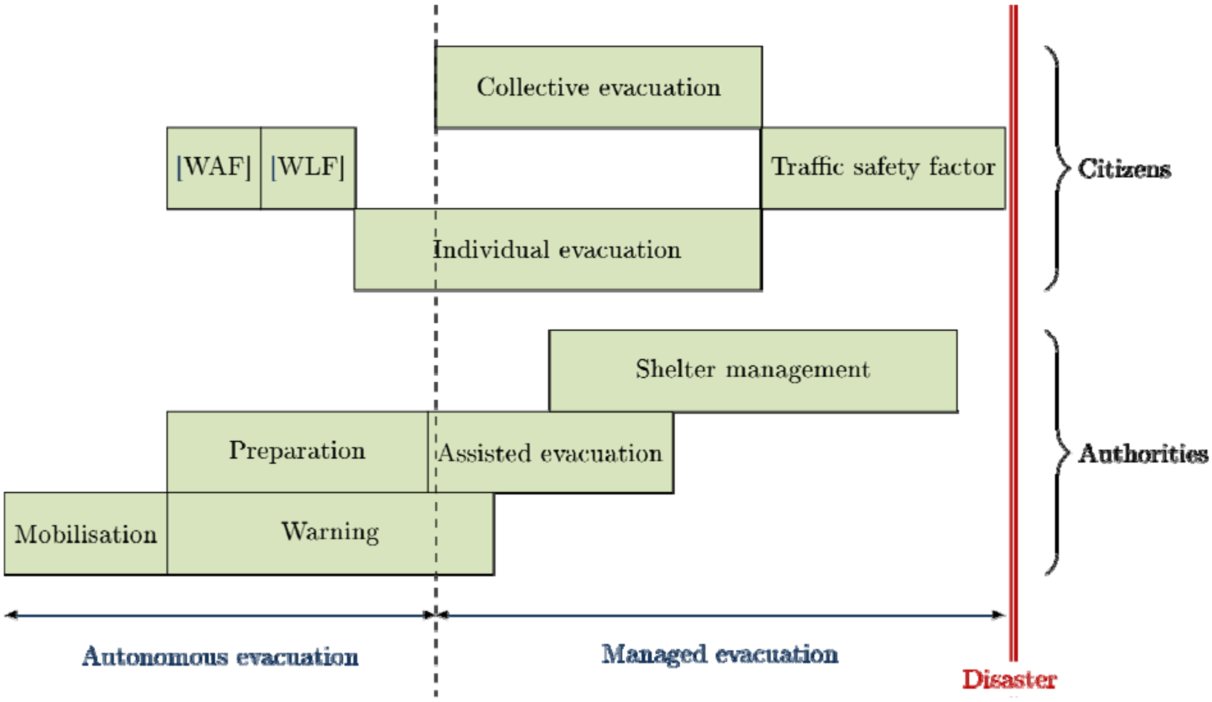


Figure 38: General evacuation timing model

Once the warning is broadcasted, individual evacuation starts almost immediatly. Warning lag and acceptance factors depend on the individuals and therefore some om them will soon leave their home and be on the roads. Under the assumption that the disaster was foreseen with enough anticipation, people will first try to return home to meet their relatives. It is not advisable to immediatly close inbound roads because it may cause panic and it will anyway be very hard to prevent people from going back home if they left a child or a parent there. The authorities should therefore wait for that moment. However, policemen can facilitate traffic at difficult places (near high-density places, at crossroads) and additional public transportation can be provided very soon.

One can estimate the delays for warning acceptance and lag factors to six hours, based on the current return of experience on real events. But as it was already stated, those times vary a lot between countries, cities according to the risk awareness of the population, the frequency of events, the success of preventive communication…The reasons for this delay are multiple:

- people do not get the warning immediatly when it is broadcasted or do not interpret it well,
- they try to get a confirmation of the warning and see what their neighbours are doing,
- they have to go back home to pick their children, relatives, or personal objects,
- …

After this unmanaged period, the authorities split the territory in several evacuation sectors. This zoning let them define a new traffic flow system and the corresponding evacuation routes. Individual evacuation will go on for a certain amount of time and observe the new system. From that time, all inbound roads should be closed and more generally, no entrance in the threatened area should be allowed, except for emergency services. A security perimeter is set up using appropriate signalling and strategically-located policemen.

When this auto-evacuation stage is over, managed evacuation can take place once people have managed to go back home and are ready to leave according to the orders. Assisted evacuees shall gather at meeting points identified in the evacuation plan (see page 125). There they will be picked up by public vehicles which will bring them to shelters as planned.

This time scale does not apply to sensitive buildings which evacuation should start as soon as possible when the warning is broadcasted, especially if it requires particular means or vehicles. As already stated, those buildings should have their own evacuation plan, which is discussed and prepared jointly with public authorities.

Authorities can also plan for successive evacuation phases, with different evacuation sectors being ordered to leave at different times. This may reduce traffic jam on the roads, and eventually speed up the whole process. However they must always take into account the fact that a large part of the population will not obey and try to evacuate before the order is given for their sectors.

Definition of evacuation sectors Splitting the town in different evacuation sectors is needed to facilitate the organization of evacuation and the communication of orders to the population. Evacuation sectors should be set up to delineate districts that are homogeneous in terms of spatial planning, density of population, height of buildings, and all the parameters which have an influence on the evacuation strategy, so that a single strategy can be applied on a sector.

Since evacuation sectors will be used to communicate orders to the population, they should be easily identified by the residents who must know in which sector they live. A strong preventive information may help to this purpose. Therefore evacuation sectors are drawn according to well-known places and major roads (examples: “the Latin quarter”, “Manhattan island”, “the sector between I-453, I-340 and I-234”…). Moreover each sector must be accessible to emergency services, have a meeting point well defined, and a route between it and the nearest shelter.

When sectors are delineated in the threatened area, one can establish routes to safe places, which may sometimes require changes in traffic management of the road network:

Reversing traffic flows on roadways to raise the number of outbound lanes can speed up the evacuation, but is difficult to implement in high-density areas (see also 5.5.1 page 88). Indeed, this requires a huge logistics to set up signage, road blocks, diversions and is very resource-consuming. However, the evacuation plan should assess the need for this option, how much time it would take to implement it and the consequences on the efficiency of the evacuation. Simulations can help to this purpose.

An inbound route should always be kept free to allow emergency services and public transportation vehicles reach the threatened area.

GIS softwares often have useful extensions with which one can proceed with different analysis of the transportation network, such as drawing service maps or shortest routes. A service zone – the base element of a service map – is a set of points of the territory that can be reached from one or several other locations in at most a specific amount of time. A route is a shortest path that joins two locations and may go through several points between those locations. In the framework of this methodology, with the “service map” tool, the planner can identify sectors in which people can reach a predefined meeting point within a certain amount of time. Those first zones can be a basis for the identification of evacuation sectors.

Evaluate the number of evacuees and assisted evacuees The ratio of assisted evacuees with respect to the total population of evacuees may be evaluated by different means:

- From returns of experience, one can estimate that 30% to 40% of the population will need assistance to evacuate. This depends a lot on the average wealth of the town but also of its density and the policy regarding cars. In New-York for example, 60% of the households do not own a car.
- Regular surveys among the population, as recommended in the data catalog, give a better insight in the ratio of assisted evacuees.
- Exercises on a smaller scale may provide a better knowledge of the behaviour of the population, but are quite difficult to organize, especially if people are asked to contribute.

Before the new traffic system is set up, self-evacuees will leave the threatened area on the roads they are used to take. After the circulation is changed, people still in the evacuation sector will have to use the new routes. At this moment, all available public transportation vehicles will be used to evacuate people from the meeting points.

Definition of meeting points A meeting point is a place where the population of an evacuation sector will gather and wait for vehicles to pick them up. A meeting point should meet the following requirements:

- be at least 800 meters away from other meeting points ;
- have at least two entrances and exits ;
- be covered if possible ;
- be easily accessible by the public transportation vehicle used ;

- not receive more than 2 thirds of its maximal capacity.

Furthermore, there should be as less meeting points as possible for an evacuation sector in order to make it easier for the vehicles to get to all of them. People who want to use public transportation gather at the meeting points they were ordered to go by the warning message or in a preventive evacuation plan. A warning message should also give the time where vehicles will come to pick them up.

Buses will bring people to the shelters. Other public transportation vehicles will only be able to bring them to other meeting points outside of the threatened area. Those meeting points should meet the same requirements as the previous ones.

Assignment of shelters to evacuation sectors At this stage, the planner assigns one or more shelters to each evacuation sector. Shelters were identified previously. Shelters are chosen so as to be as close as possible from the evacuation sector in order to reduce the displacement and to speed up evacuation. The capacity of each shelter should of course be equal to or greater than the number of people who are assigned to it (taking into account the estimations of people who will come to a public shelter). Furthermore, the total capacities of all the shelters assigned to an evacuation sector should be equal to or greater than the actual expected number of people who will ask for a public shelter.

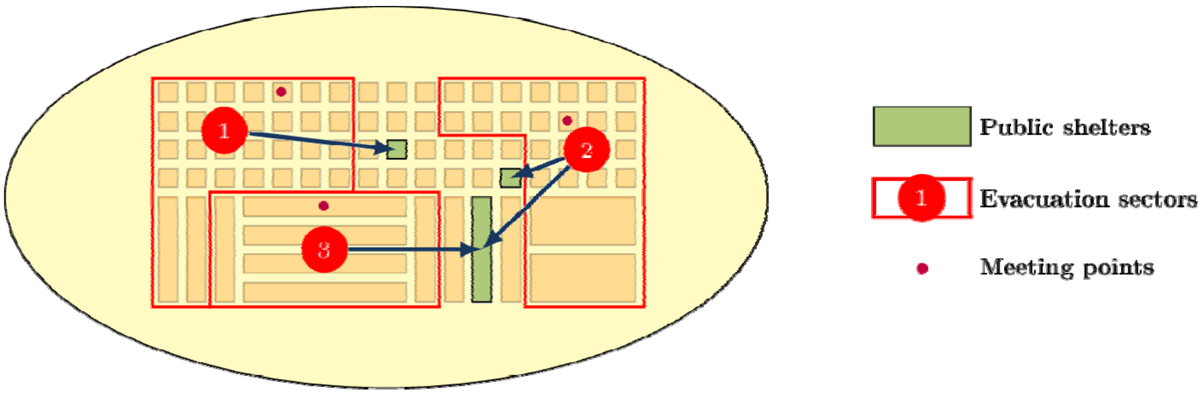
As it has been done for assisted evacuees, the number of people who need public sheltering should be assessed during the planning stage. This can be done through returns of experiences, or surveys. Without any additional information, one can assume about one third of the population will need to go to public shelters.

Definition of exit points and routes to shelters From the risk maps made in previous steps, a spatial analysis helps to define routes to shelters. Exit points are located on those routes, at their intersection with the boundaries of the threatened area. Self-evacuees must know the exit points and the routes before the disaster strikes. This can be achieved by efficient preventive information campaigns. Warning messages can remind them of the behaviour to adopt.

Of course the routes to the exit points should be as fast as possible. It is easy to identify those routes in normal conditions using a GIS. However during an evacuation, traffic jam is highly likely to occur, especially near the exit points. That's why authorities should share out traffic among several roadways, and avoid busiest roads as much as possible. The GIS software will draw routes from meeting points to exit points and the planner can adjust them so that they do not cross (which would involve congestions) and the travel times of the different routes are similar.

It is possible to locate the districts that are the most far away (in terms of travel times) from the meeting points, and to apply a particular plan for them.

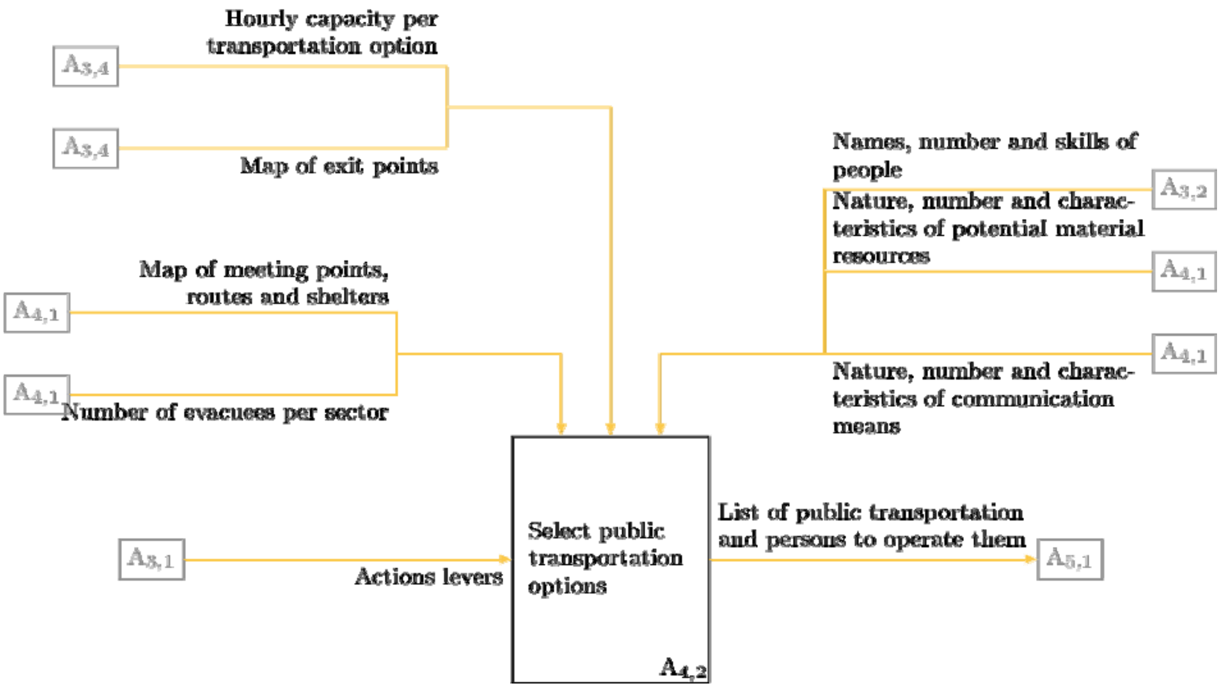
Example:



Evacuation sectors, shelters and meeting points

Overall evacuation strategy

Select public transportation options for assisted evacuation



Now that shelters and meeting points have been identified, the authorities must prepare for assisted evacuation. To this purpose, they should define the types and numbers of required public vehicles. But they must not forget people who operate those vehicles, who have to be clearly identified too, and whose actions should be well described before the disaster.

Select public transportation options During the self-evacuation stage (see Figure 39), buses keep their usual schedule in order not to disturb people who are used to use them to go back home. After this stage, buses are requisitionned and get to the meeting places they were assigned to. At meeting points, buses should first take sensitive people to bring them at shelters (children with their parents, old people). Small buses can also be used to take dependants directly at home, especially for people who can't join the meeting points on their own.

City trains and subways are similar to buses. The main difference is that they can only pick up people if the meeting place is near their lane. City trains may be closed due to the forecoming event, but if not, this solution can dramatically increase the capacity of evacuation and must not be neglected.

There are still more constraints for the use of trains. However their capacity is very high. Therefore they should be used as much as possible to evacuate people who live near a train station.

Helicopters provide only very limited capacities and may not be used as a general option for evacuation. However, they can provide additional support for dependant people needing constant care and who have to be evacuated to a safe hospital in a short delay.

During the assisted evacuation stage, one must remember that inbound roads should be closed, except for emergency services, to prevent more persons from coming into the threatened area, and to facilitate the displacement of public transportation vehicles.

Identify the required staff Firemen can help to warn people at home and to evacuate dependant people. They will constantly be called upon in places where accidents occurred. They can also go through each house or building to check if people have already left.

Medical staff (nurses, doctors) can help to evacuate people who need medical care.

The police has an important role in setting up the new circulation map and facilitating the traffic at crossovers. They have to regulate traffic to reduce congestion at previously-identified hot spots and exit points. They can direct people to shelters and must know the evolution of the situation to inform people in their cars. After the evacuation, they have to enforce law in deserted districts in order to avoid robbery, assault or degradations of individual homes and to appease the population.

Finally, drivers play an important role at this stage because they have to operate public transportation vehicles. Their contracts should specify their role in the evacuation process and make it mandatory for them to assist the authorities, at least for a given amount of time before being replaced by fellow workers. Their contracts should also state that they have to be ready in less than two hours if called upon by their employers.

Example:

Collective evacuation

For a full example of collective evacuation strategy, see also the example evacuation plan of Bordeaux

The networks

Bordeaux has two public transportation networks: buses and city trains. Both are operated by a private company, under a delegation contract with the metropolitan area. The private company, Keolis Bordeaux, has 2 100 employees, 1 350 of which are drivers.

The city train network has three lines (A, B and C). It is used by 165 000 every day:

- 70 000 persons on line A,
- 70 000 persons on line B,
- 25 000 persons on line C.

The network has 74 trains (62 of new model, 12 of old model), operated by 353 drivers. The capacity of each train is estimated between 4 and 6 persons per square meter, which leads to about 230 to 345 persons for the new train model, 265 for the old one. The frequency of the city train is at most one train every 4 minutes in peek times.

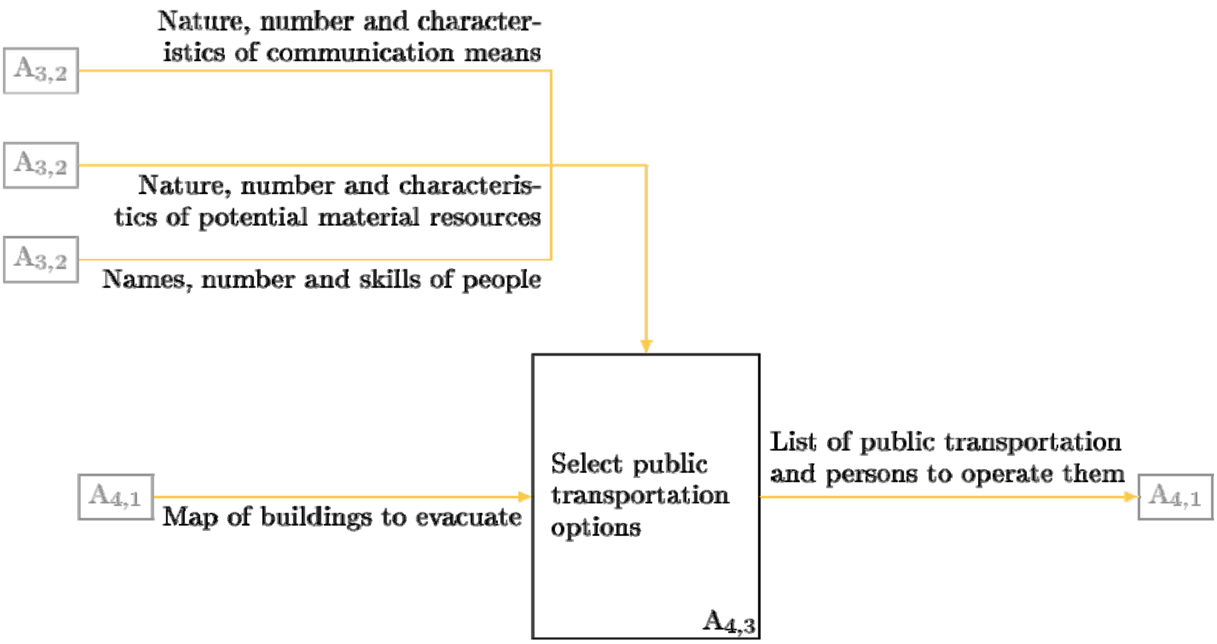
Keolis has also 450 buses and 26 special vehicles equipped for disabled people.

Evacuation of La Bastide

We assume that one third of the population of the district will require assistance for the evacuation. The district has 20 000 inhabitants, which means that about 6 700 people will use public transportation.

Line A of the city train goes through the district of La Bastide from South West to North East, and has seven stations in the district. It would be possible to stop the train between stations, but the railway is at the middle of the road, between the two lanes, and this would cause safety problems if the circulation is not fully cut. If we assume that the whole evacuation is to be done by city train, 27 trains are required to evacuate all the inhabitants. It is possible to provide this capacity in about two hours and a half. On the other hand, a standard bus can take about 100 passengers. If the evacuation has to be done by bus, 70 buses will be required.

Define the communication strategy



Having a good communication strategy to inform people about the evolution of the disaster and to disseminate orders and advices is crucial for the evacuation to take place as well as possible. At this stage of the preparation of the evacuation plan, all the roleplayers must also be trained and prepared for their assignment.

Set up preventive information among the population When the plan is prepared, and before the disaster strikes, on a regular basis, the population should be reminded of the risk on the city and its expected consequences in the different scenarios. The evacuation plan should also be presented, and a summary of the main points that concern people should be included in the communication documents.

Here is a proposed agenda for the information meetings to the population.

Example:

Agenda of the information meeting

Duration: 2 hours

- The risk in our town: maps, scenarios, past events
- How do we set up the evacuation plan? Why and how to evacuate?
- The evacuation plan
- The different kinds of evacuation: in-place sheltering, horizontal evacuation
- A new circulation map: why and how?
- Specific signalling during evacuation: signs and meaning
- Communication media which will be used for information and dissemination of orders
- How should I behave in case an evacuation order is issued?
- Contacts for additional information
- Questions and answers *(during this stage, we must be ready to integrate important remarks of people and take them into account in the evacuation plan)*
- Distribution of synthesis flyers with coordinates of contact persons and instructions about how to consult the evacuation plan

Warning Different warning messages should be prepared according to the expected scenarios. When the event is forecasted, the same warning message will be broadcasted using all available communication media previously identified. The content of this message should at least describe the following points:

- inform the population about the gravity of the disaster;
- convince people of the necessity to evacuate;
- give general details about how the evacuation is going to take place (at this stage, the authorities can inform people about the setting up of evacuation sectors with specific instructions).

Moreover, the message should meet some requirements:

- never let people doubt the event is actually going to happen;

- be persuasive: it is impossible to force people do something, but the message should convince them that the evacuation order is for their best interests;
- be flexible to meet the particular requirements of the incident;
- aim to reduce worry as far as possible: an evacuation has a significant psychological impact on population but a good communication strategy can make the difference and avoid panic-linked disorders;
- take into account different language groups: of course the national language will mainly be used by the announcements but the authorities can reach more people if they take into account specific ethnics and languages. The social analysis should be done during the planning stage;
- describe with a good accuracy the districts that are threatened;
- describe the event that is going to happen and why it is a danger for the population;
- remain short, precise, and clear;
- tell that the decision to evacuate was made in agreement by all the comptent authorities (local, national, regional) so that it is well accepted by the population;
- not guarantee that there will be no risk if the orders are obeyed;
- be repeated on a regular basis, for instance once every 15 minutes, to maintain a good communication with both people at home and evacuees.

An evacuation order should have the following content:

- type of evacuation: in-place sheltering (how?) or evacuation outside of the area;
- when does collective evacuation start?
- shelters and routes to shelters;
- which public transportation option can be used?
- information about the state of the disaster if it is already started;
- contacts in case of questions, websites.

It is very important the message is not changed too often. Only if new information is available about the event can it be changed. But the authorities must make sure everyone has heard the same orders.

All communication means do not have the same efficiency. Local communication from a close trusted source is usually a lot more persuasive than official standardized communication. Anyway, the evacuation plan should address the fact that some of the communication networks can be disrupted due to the coming disaster. Using a wide-range of message vehicles is therefore necessary to ensure the message will be heard by most people. Also, the decision maker should not rely solely on national media although they will be the main channel to communicate.

Example:

Warning messages

Pre-warning message
State services have just informed us that the forecasts of water levels of the Blueriver in Bayside will go beyong the pre-warning threshold at .... A flood may therefore happen for the next high tide at .... The water level is expected to reach ...meters in Bayside and should only result in a small flood with limited damages. In the following days, the tidal coefficients will be .... The levels in Bayside should be lower than ...meters. A new message will be broadcaster tomorrow at ....

First warning message
We inform you that, following the forecasted flood, an evacuation may be ordered by the authorities. Once evacuated, you won't be able to get back home before the end of the event. Before the evacuation order is given, we invite you to:

- shutdown your heating devices and your electricity network, close your water and gas networks;
- tie your heavy objects that may float;
- if possible, move your precious objects or dangerous items on the first floor;
- gather warm and dry clothes, linens and towels, blankets, some money, your personal IDs and your mandatory medicines;
- not forget to shut your door when you leave.

Be ready to evacuate as soon as the order is sent and follow the instructions of emergency services. Do not leave before the order.

Second warning message
Following the flood forecasts, the authorities decided to evacuate the district .... This decision is necessary for everyone's safety. Everything is done to make it happen as well as possible. Do not panic. Once your items are ready, if you decide to evacuate by yourself, close your houses, pick up your relatives and leave the district following the route you were assigned to. If you need assistance for the evacuation, go to the nearest meeting point. We count on your well behaviour.

Third warning message
We inform you of a high flood risk in the following hours. A maximum level of ...is anticipated. We strongly advise you to take the following actions:

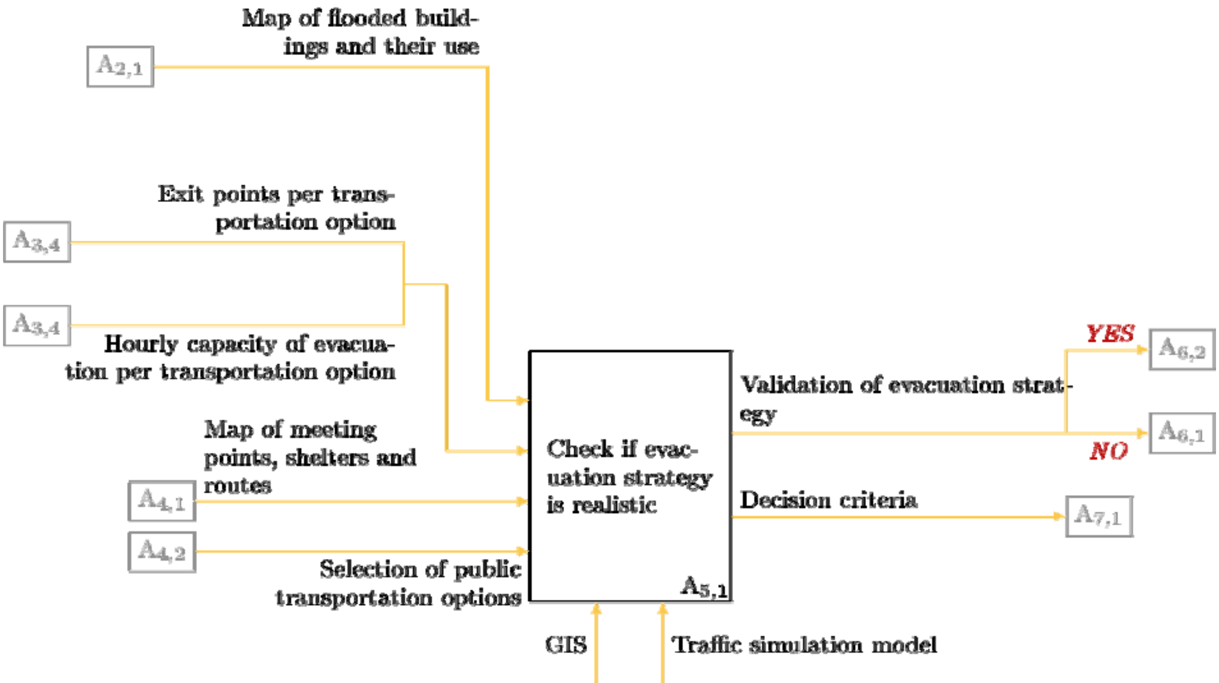
- look at your basements and ground levels to detect a possible infiltration of water;
- move all sensitive items out of your basement and bring them to higher levels;
- move out or up all dangerous items (electric devices, heating devices, cars, toxic products);
- as soon as you see water in the streets, move upstairs and listen to instructions on radio ....
- contact ...if you have questions

CHECK IF THE EVACUATION AND COMMUNICATION STRATEGIES ARE REALISTIC

Now the planner has gathered all the elements to make the evacuation plan and has selected an evacuation strategy for each risk scenario defined previously. He has now to check it to see if it is relevant considering the available resources and time to evacuate. The major points are to check if the capacity of networks and the human and material resources are sufficient, that all the population will be tackled by the chosen communication strategy, and that the population and roleplayers know the plan.

To make sure the capacity of networks is sufficient, the planner will use the previously-made maps of the threatened buildings and the maps of the transportation options, meeting points, exit points, shelters and routes. A GIS software will help to intersect informations from those maps. Then we have to make sure enough staff and materiel resources are available at crisis time to implement the plan.

Check if the evacuation strategy is realistic



First the planner has to check if the capacities of meeting points and shelters are sufficient. The basis is the number of people who will seek refuge in public shelters, which is obtained from the data collection stage. Those will stay in shelters for the whole duration of the event. When it is over and the city is safe again, the authorities will have to plan a bus service to bring people to their homes. For shelters, the planner must check that the capacity of each meeting point and shelter is higher than the estimated number of people needing sheltering and assigned to this place. Refer to 5.5.3 page 101 to know how to estimate the capacity of a shelter.

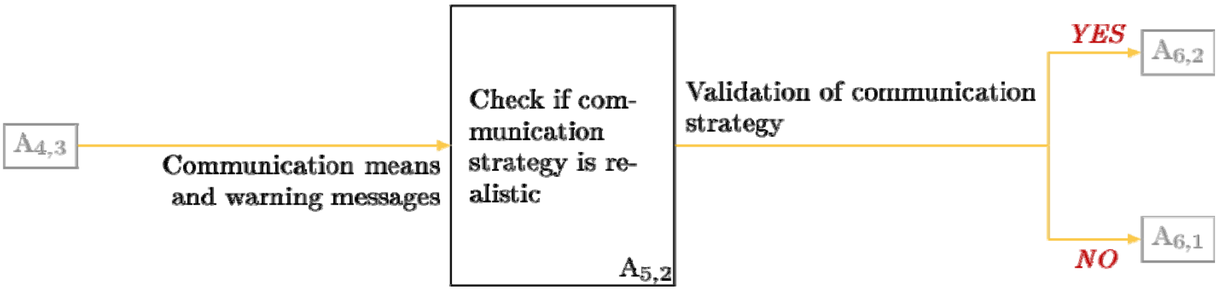
Then the planner must check if the total capacity of evacuation per time unit is sufficient to evacuate all people before the start of the event. If not, it is better to advise people to stay at home or to seek shelters in places near their homes. Indeed sending people on the roads when the disaster starts is the worst thing to do. Using a traffic simulation model, the planner can have a detailed insight on the functioning of the network before the crisis. This helps him to estimate the time needed for a public transportation vehicle to go from a meeting point to a shelter. The total number of people who can be evacuated through public transportation options per unit of time may be estimated by the following formula:

$$N = \sum_{\text{vehicles } i} \frac{c_i}{\frac{2d}{v_i} + t_i}$$

with d the distance between the meeting point and the shelter, vi the average speed of the vehicle i, ci the capacity of the transportation vehicle, ti the delay needed for persons to go out and enter in the vehicle.

Alternative routes should be planned in case some used in the natural shortest routes are closed due to roadworks.

Check if the communication strategy is realistic



The purpose of this part is to check that the communication strategy is efficient and that the evacuation order will be heard by everyone in the threatened area.

Warning time In order to let the authorities prepare for the evacuation, and to avoid panic and crowd movement, it may be useful to differ the warning and to issue it at specific time slots. This is particularly true if the event is not expected before several hours, which gives enough time to prepare and split up the tasks in different phases. It is a sound idea to differ the warning according to the nature of the evacuation sector (offices, residential), to the number of people in the area, to particular events (concerts, matches…).

It is generally advisable to avoid sending the first warning during commuting times (between 7 and 9 o’clock in the morning, and between 5 and 7 o’clock in the afternoon), because roads are already nearly saturated and issuing a warning, even saying that people should leave later, would result in more cars on the roads and huge congestion. In the same way, a first warning during night will not be heard by many people but is likely to cause panic for the people that are woken up.

Check the warning efficiency When the communication strategy is chosen, the planner has to check that everyone will receive the warning when it is issued. This also concerns non-residents like tourists. This can be made through a survey or an exercise. During the survey, it is important to make sure that everyone knows what he has to do and where he has to go. A particular attention can be turned to sensitive persons and dependants.

Inform the population about the evacuation plan When it is prepared, the evacuation plan must be made available to the public, for instance in the town hall. People should be able to consult it. This release should be preceded by a public information meeting.

If at this stage, the public expresses disagreements with the evacuation plan, this one should be revised as much as those remarks are justified. After a sufficient amount of time, the plan is validated and signed with all the organisms which contributed to its establishment and which have to provide resources or staff during the evacuation. The public information should be as clear as possible, define all ambiguous words, and answer to the questions of the public. It is important to remind people of their civic responsibility.

How to inform the population about the evacuation plan? There are many options for the local authorities to communicate about the plan:

- flyers in mailboxes, in the town hall, tourists centers, local authorities,
- maps and explainations in the town hall,
- local newspaper,
- specific information document to all inhabitants, by name,
- information website regularly updated,
- regular training about the behaviour, organized by associations, education centers, firms: those trainings are based on the evacuation plan and on the new traffic system, and are specific for each district,
- regular information of all roleplayers in emergency management about the assignments they will have during the evacuation.

Exercise the evacuation Exercising is a key element of the planning. For evacuation, full-scale exercises may be very difficult to implement, but some components can be tested. A range of organizations as wide as possible should be involved in those exercises. They should over time address the full range of capacities and responders who might be involved in the process. The overall purpose of the exercises is to make sure the evacuation plan works well and that is well understood and applied by the population and the emergency services. If there is not enough population on site, one can hire extra players for the occasion.

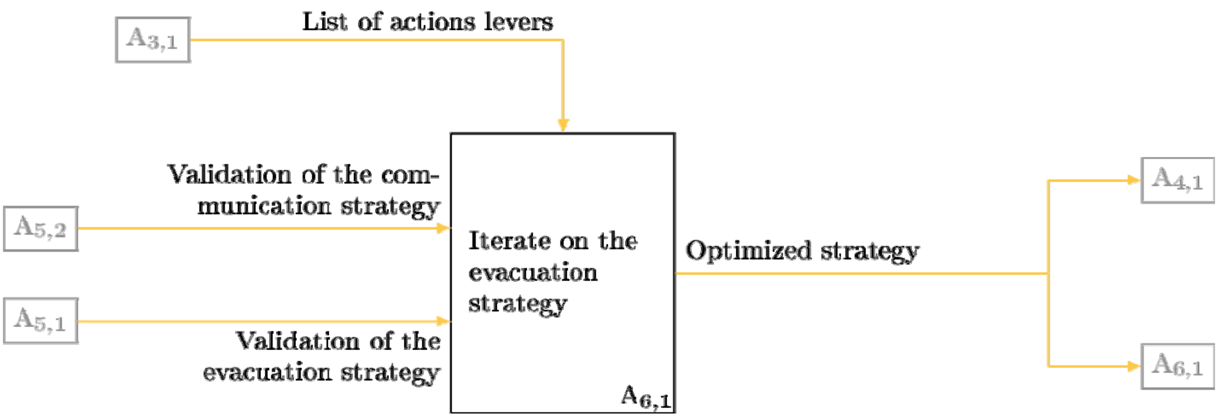
Of course, when an exercise is organized, all its results and the actual events should be recorded through a standardized review process for further return of experience. Each individual organization involved in evacuation management, and especially those who will sign a contract with the local authorities, are responsible for the training and preparation of their own staff.

An exercise should at least be organized at the very beginning when the evacuation plan has been validated and signed and when the population has been informed of its existence. Afterwards, regular exercises are useful to maintain a high level of risk awareness in the population: one exercise each year or each two years is generally a good rhythm. More frequent exercises can also be organized in public establishments and firms to test their reaction to the event.

ITERATE ON THE EVACUATION STRATEGY AND WRITE THE EVACUATION PLAN

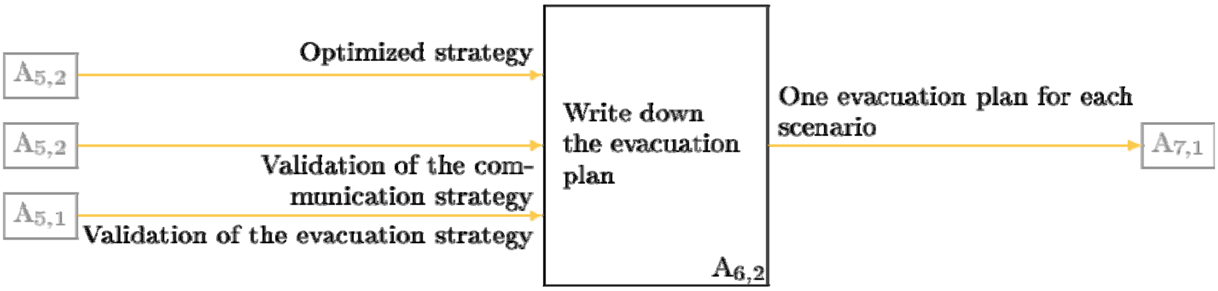
If the strategy has been validated at the previous step, it may be optimized to improve some details of its implementation. Then the strategy has to be described in a written evacuation plan. This plan will help to take the necessary actions in real-time when a disaster is forecasted.

Iterate on the evacuation strategy



If an evacuation strategy is found to be not realistic at the previous stage, this step is needed to make an iteration in the process of preparing the evacuation plan. The planner has to use one of his actions levers identified above to update the strategy so that it fulfils all the requirements and allows a maximum number of persons to be evacuated before the disaster hits the territory. After this iteration, the strategy will again be assessed. The return of experience after evacuation exercises can provide an objective evaluation of the strategy.

WRITE DOWN THE EVACUATION PLAN



When all strategies have been set up and assessed, the evacuation plan has to be written down in a document. This document will present the different strategies in a synthetic and convenient way. It is made for emergency services and all the roleplayers who have a mission during the crisis. It must keep simple to be understood by everyone including the population itself.

Here we present an example of the structure of such a document.

Example :

Evacuation plan outline

1. The hazards in our city and the risk scenarios
2. Risk scenario: flood hazard, high level *The following items are repeated for each risk scenario.*
   (a) Chronology and organization of the crisis management system

	Emergency response unit
Location	Town hall, 2[nd] floor, room A56
Assignments	Coordinate actions of firemen and police, communicate with people
Activities	Chronological list of actions that the cell has to carry out
Members	John Doe, Jane Doe

   (b) General chronology of evacuation including actions at different steps
   (c) *Reflex-decision cards sorted by theme:*
   - Warning
   - Assistance to people at home
   - Traffic management and closing of inbound roads
   - Shelter management, registration
   - Particular establishments

   Each reflex-decision card briefly explains the purpose of the mission, the resources needed, the roleplayers, and the chronology of the action.

   (d) Reflex-decision cards sorted by roleplayer, including the contact details of the roleplayer, his *assignments and the actions he has to carry out during and after evacuation*
   (e) Appendices: risks maps, shelters maps, meeting points maps, circulation map with needed diversions and signalling, warning messages, directory of roleplayers
3. Glossary
4. Further recommended documents

Part III: toward a coherent portfolio or risk management approaches

In order to generate transversally coherent results within WP4, the WP4 team members have identified 3 frameworks. The basic idea will be to apply these frameworks to the combination of insurance programs, urbanization and spatial planning, damage to businesses and recovery, post-crisis response, risk communication and evacuation plans. The goal is to generate, by month 36, a coherent portfolio of risk management approaches. In the course of this process we will identify the emerging questions generated during the field work and the analysis of the results. During a THESEUS Methodological Workshop, organised in Guyancourt, October 25-27, the following frameworks have been chosen: the Resiliency paradigm, the context of the SPRC model and a yet to be defined "emerging framework" focusing on adaptation to go beyond prevailing conditions before erosion or flooding events.

FIRST COHERENCE-BUILDING FRAMING : RESILIENCY[8]

OPERATIONALIZING THE CONCEPT OF RESILIENCE

In order to operationalize the concept of resiliency within WP4, the theoretical foundations used by, and the operational approach of, Wardekker (2010) is being used and tested as a first iteration. This relies on the concepts of homeostasis, omnivory, high flux, flatness, buffering and redundancy as defined within Wardekker (2010). This approach can be framed as the following fourth recommendation for coherence building:

For each WT within WP4, its contribution to resiliency will be analyzed, both conceptually, and during field testing, in terms of the following component of resiliency: homeostasis, omnivory, high flux, flatness, buffering and redundancy. If needed, these concepts will be refined.

Box 4: fourth recommendation regarding the development of WP4 overarching framework, operationalizing the resiliency principles.

Here below we develop in bullet form the way these resiliency principles may be applied within each worktask. Details can be found in each of the WT internal deliverables.

[8] Contributors : general writing and design : Juan Baztan, Loraine McFadden and Jean-Paul Vanderlinden. Application of resiliency framework to specific WT: WT4.1: Phoebe Koundouri, Kyriaki Remoundou, Bénédicte Rulleau; WT4.2 and 4.3: Loraine McFadden and Edmund Penning Rowsell; WT4.4: Luca Pietrantoni, Gabrielle Pratti, Fabio Zagonari; WT4.5: Juan Baztan, Pedro Diaz-Simal, Jean-Paul Vanderlinden; WT4.6: François Hissel. This section rooted into the theroretical development of Wardekker et al. (2010).

HOMEOSTASIS: MULTIPLE FEEDBACK LOOPS COUNTERACT DISTURBANCES AND STABILISE THE SYSTEM.

Application to Insurance programs:

- Floodings and shoreline erosion should be insurable.
- Quality of information given on the different contracts, special clauses etc.
- Clarity of responsibilities of public or private agents of insurance schemes in case of disaster.
- Ability of insurance companies to update their contracts and operation given previous experiences (own and from around the world) so that they are tailored to local conditions.
- Ability of insurance schemes to adopt measures that minimize risk of the most vulnerable.
- Monitoring capacity of insurance schemes on the impact these have on people with different levels of vulnerability.
- Monitor the premium rate, the deductible level and the insurance cap level to assure demand for their policies.
- Ability of insurance companies to (re)-integrate local participation at different stages of the design of an insurance scheme after an event.
- Ability to update knowledge regarding scientific data, research developments and scenarios related to climate change, flooding etc.
- Ability to cooperate with local authorities to update their protection measures given previous experiences (and so decrease the probability of risk and size of payouts).
- Cooperative or community (instead of individual) insurance schemes may reinforce social cohesion.
- Multi-country insurance that pools the risk of impacted areas has a positive effect on those who suffer disproportionately from such disasters.

Application to spatial planning and to business disruption and recovery:

- The road system could be designed to enhance the removal of water from the area in case of flooding.
- Flexible structures and infrastructure would provide a stabilising feedback as well.
- Flexible flood defences (e.g. small scale ‘flood beams’ and large scale flexible storm surge barriers) could be closed when necessary, while not preventing access at other times.

- Critical facilities, such as the crisis management center, could be made mobile.

Application to Post-crisis response and some examples:

- Early-warning and response mechanisms could limit the impacts of disturbances.
- Social cohesion.
- Flexible structures and infrastructure.

Application to risk communication

- Post event lessons learned should be tightly integrated in the gathering, treatment and diffusion of information on risks.

Application to Evacuation plans:

This is the main principle which is addressed by the preparation of mass evacuation plans. Well informed inhabitants who know the future risk, which consequences it can have on their own life and how they should react to it are able to carry out necessary actions to protect themselves from the coming event, thus decentralizing the crisis management and making it more efficient. Of course one can't expect every citizen to be warned in time and to do exactly what he was told, but this preparation removes a real burden on the authorities who then only have to manage unforeseen events or dependent people. the homeostasis principle emphasizes the need of three components in an evacuation plan :

- Evacuation-aware urban planning. First of all residential zones should obviously be built as far as possible from places at risk. this is an evidence but one has to notice that it was not applied in the past years. Of course coastal zones are subject to a lot of pressure and decision makers have to deal with different possible uses of the territory. Sometimes nothing can be done and they only have to cope with a given situation. But for new urban zones, the road networks, the location of public buildings which can be used as refuges, the position of public services involved in crisis management (firemen, policemen, technical services of municipalities), the public transportation should be thought about not only in a usual situation but also as means to allow for a better evacuation of people in crisis times.
- Preventive information of the population of the risks they are faced with and wide dissemination of the evacuation plan before the event. Most of the European countries already have regulations to make municipalities assess the risks on their own territories and prepare for it. The evacuation plans should therefore be included as a part of these emergency plans.
- Communication of forecasts in an understandable way for an impending event. This component can make the best use of classical media (TV, radio, alert bells) as well as new information technologies (sending of an area-wide phone message, GPS). Clear responsibilities of the different parties involved in emergency management and good communication procedures

during the crisis. This is a crucial point, not only for the implementation of an evacuation plan, but for the whole policy of crisis management.

Social cohesion is a critical dimension of Homeostasis. This may be the most difficult part to implement but can have a really positive feedback on the way the evacuation is realized. This factor can help replace an individual and sometimes unstructured response with a collective effort to proceed with the evacuation. In this field, one could for example organize carpooling for people who can't drive themselves. In some places, a "responsible person" is given the task to make sure everybody has been warned of the impeding event and has let his house. Unfortunately, the level of social cohesion and the voluntary involvement for the civil protection varies a lot across the different countries and in some places it may still be an unreachable option.

OMNIVORY: VULNERABILITY IS REDUCED BY DIVERSIFICATION OF RESOURCES AND MEANS.

Application to Insurance programs:

- Helping people to implement measures in order to protect their properties (special precautions)
- Helping local authorities to implement protection measures.
- Allocate part of the insurance fees in order to finance protection measures in the most affected areas.
- Promoting development and effectiveness of the social network in terms of cohesion so as to reduce risk and size of payouts.
- Promoting awareness of public on natural disasters and on the link between community vulnerabilities and policy options.
- Integrating scientific output regarding possible scenarios of events.
- In case of a huge payout assuring access to alternative funds/financial resources.
- Assuring alliance and setting a common emergency plan with public or private sector or organizations.

Application to spatial planning and to business disruption and recovery:

- Relocating existing functions to other spaces/buildings (multiple locations to fulfil the function).

Application to Post-crisis response:

- Diversification of energy supply options.
- Diversification of transport of goods. In a crisis, functions could easily be relocated to other buildings in other parts of the area.

Application to communication

- All media, including informal ones, should be used within the context of risk information sharing.

Application to Evacuation plans:

For the evacuation plan process, the main goal is to bring people at a safe place. therefore the fulfilling of this requirement calls for different items:

- Different kind of refuges available. The authorities should anticipate the evacuation by selecting safe and equipped refuges. These refuges must have a sufficient capacity. They have to be located at different places so that if one place is threatened by the event due to a worsening not foreseen like a dike breach, people can be sent to another place in a reasonable amount of time.
- Also, selecting different types of refuges (high buildings near the flooded zone, large halls farther, and small rooms in different hotels) might be appropriate: the whole evacuation plan will then be less subject to unpredictable harmful events such as the collapse of a building, a power cut, or an unexpected rate occupation rate of hotels at the time of the event.
- Different pathways from the threatened zone to the refuges. A refuge with only one access point is not a fully reliable safe place. If the access point – for instance a road – is cut because of the flood, a truck overturned across it, or a car fire, the people will not be able to reach it any longer. If the immediate surroundings of the refuge is also at risk, then the situation is really serious and may lead to numerous casualties.
- Different modes of transport. This is a crucial issue for the preparation of an evacuation plan. One should combine several alternatives to allow for a faster and more secure departure from the threatened zone. Road is of course the first choice. Public transportation can reduce the traffic on the roads. Before the flooding, rail is an efficient and fast way of moving a lot of people. When the flooding starts, one can consider using airborne vehicles for special regions where the usual road transportation might be too dangerous.
- Different sources of energy. Power supply is a vital need for crisis management and power shortage in a refuge may worsen the situation of people. However floods often damage the distribution network of even the power plants. Localized sources of power like solar plants on the roofs of a building or simply personal electricity generators can compensate for a lack of power during a small amount of time.

HIGH FLUX: A FAST RATE OF MOVEMENT OF RESOURCES THROUGH THE SYSTEM ENSURES FAST MOBILIZATION OF THESE RESOURCES TO COPE WITH PERTURBATIONS.

Application to Insurance programs:

- Quality of information and clarity given on the conditions under which a payout is received so that is done faster.
- Collaborating with different insurance companies to work together and make faster the process.
- Keeping only a certain percentage of high risk contracts among clients.
- Allocating payouts giving priority to the most affected or according to social criteria (e.g income).
- Encouraging collaboration with local authorities (having already set a contingency plan), NGOs etc in order to increase reliability and timeliness in case of an event.
- A competitive insurance market can provide a wide availability of insurance cover and contribute to high flux by assuring distribution of the risk and higher coverage of the population.

Application to spatial planning:

- Shorten the planning horizon for buildings, and urban planning in general. For instance, one could plan for houses to be replaced after 30 years rather than 50; thus ground level can be elevated/modified more quickly.
- This can be combined with a ‘cradle-to-cradle’ approach and the use of modular elements in buildings; building a “rebuildable city”. If elements of constructions could be reused or deconstructed and later rebuilt, the area could be modified relatively quickly, and at lower costs, to accommodate changing conditions.
- Planning easy-to-modify land-uses in areas that may need quick modification.

Application to business disruption and recovery:

- Rapid decision making is needed when disruption strikes, to retain your customers; this is the highest priority here, and this required speedy action.

Application to Post-crisis response:

- Elements of constructions could be reused or deconstructed and later rebuilt.

- Quick notification of high tides, allowing residents and officials to take measures early on (high flux of information)
- Planning 'green areas' and other quickly-modifiable land-uses in areas where future changes may be required (high flux of land use).

Application to risk communication

- High flux in terms of risk communication entails high level of cross stakeholder information sharing, which is closely associated with participatory processes and practices.

Application to Evacuation plans:

Whether the changes are fast or on long-term, the property can lead to different expectations:

- High flux of data allows for quick information of the citizens. The sooner residents and authorities are aware of the impeding risk, the more time they will have to get prepared and the better the response will be. Therefore alert systems should be as accurate and fast as possible.
- High flux of organizations to keep a high level of wakefulness. Littorals are subject to changes along the years, with the sea rising, the climate being altered, industrial zones growing, and more population gathering on the sea side. An evacuation plan should also therefore take into account these changes, by being updated every once and then. No plan can remain valid for more than ten years. Land use planning and protection structures have to be adapted in the same time.

FLATNESS: THE HIERARCHICAL LEVELS RELATIVE TO THE BASE SHOULD NOT BE TOP-HEAVY.

Overly hierarchical systems with no local formal competence to act are too inflexible and too slow to cope with surprise and to rapidly implement non-standard highly local responses.

Application to Insurance programs:

- Direct , easy access of personal contact of each beneficiary with the insurance institution.
- Participative process in identifying high risk zones not possible to be insured.
- Flatness can be promoted by tailored insurance schemes according to local conditions, the needs and characteristics of local stakeholders and households.
- Allow local participation in the design of insurance schemes to increase flexibility and response.
- Facilitate payouts in terms of quick response avoiding bureaucracy and time consuming paper work

Application to land use planning:

For the time being no application to spatial planning.

Application to business disruption and recovery:

- Flat hierarchies should promote rapid decision making when disruption strikes, such as changes to business location or procurement of replacement machines or other equipment.
- Retaining customers is the highest priority here, and this required speedy action.

Application to Post-crisis response:

- Not having overly complex procedures for decision making, bureaucracy, and a limited influence of local actors on policy.
- Population allocated the competence and power to respond to possible problems, self-reliant, self-sufficient, self-regulating policymaking should be more participative and tailored to the local situation.

Application to risk communication:

One of the major shifts in risk communication for the last 20 years lies in the "flat" nature of ICT based risk communications. Nevertheless this leads to greater potential of social amplification (se ID 1.5). Flatness is thus taken for granted yet some kind of extended peer review process must be envisioned.

Application to Evacuation plans:

With limited number of actors and levels of administration, information about the state of the event and decisions will move faster along the hierarchical levels and operational actions can be carried out earlier.

- Local response: One way to fulfil this requirement is to make local decision-makers and technicians responsible for the local management of the event. Higher levels should only be involved when a large-scale coordination is required. With this approach it is also possible to provide responses tailored to the local situation.
- Involvement of the public: Already stated earlier, the involvement of the public is an essential issue of crisis management. One notices that many citizens are willing to help the authorities when an event occurs, but they do not know how to be useful. A well-informed public whose task force is channelled to high priority stakes through preventive information and planning can prove more useful than referent operational services to ensure safety at a local scale. this concept is referred to as "holistic governance", which aims at "creating a clearly communicable safety-culture in which professionals and residents participate".

BUFFERING: ESSENTIAL CAPACITIES ARE OVER-DIMENSIONED SUCH THAT CRITICAL THRESHOLDS IN CAPACITIES ARE LESS LIKELY TO BE CROSSED.

Application to spatial planning:

In addition to buffering capacity against disrupting events, one could buffer against disrupting trends by leaving plenty of open spaces (parks, squares, etc.). These could change function relatively rapidly if the future situation would demand this, thus increasing the flexibility of the area's urban planning.

Application to business disruption and recovery:

- Unlikely in the business world, especially to counter the impacts of rare events.

Application to Insurance programs:

- Link premium to risk reduction measures that promote buffering (e.g flooding-resistant functions on ground level) through economic incentives (reduce premium for those who invest in mitigation or loss-reduction measures).
- Differentiate the premium for the same amount of coverage or protection (rate schedule).
- Require that certain standards be met (e.g building codes) before issuing an insurance policy (mitigation measures).
- A edge fund kept by the insurance companies and/or the government to enable them to absorb big natural disaster without collapsing while multi-criteria system in allocating the fund based on the emergency of the situation increases buffering capacity.
- Assure that the money to pay for the losses are already in hand through an indexed based or parameterized cat bonds.
- Insurance firm to purchase an indemnity contract against claim payments above a certain amount.
- Possibility of sharing risk of a huge payout by cooperating with other insurance companies, public sector, EU.
- Ability of insurance institutions to offer payouts giving priority to the most affected or according to social criteria (e.g income) increases buffering capacity.
- At least the insured part of population is offered relief and resources are allocated directly to the more disadvantageous.
- Ability of insurance schemes to be reliable and respond on time promotes buffering.
- Raise deductible levels so that the payouts from any disaster would decrease.

- Set a cap on the maximum insured value.

Application to Post-crisis response:

- Water retention areas.
- Other areas could be elevated, to house essential functions and to serve as flood refuge.
- Main roads leading into and out of the area could also be raised. This would allow them to be used during flooding, for instance for evacuations.

Application to risk communication:

- Relying on all medias, including informal information sharing through social networks that ARE NOT necessarily ICT based.
- Relying on participatory processes.

Application to Evacuation plans:

- Making water retention fields: This measure is commonly adopted, not only for the emergency management but also to protect territories: fields are marked as reserved and can not be built upon, so that they will store a part of the water when the flood occurs. Water retention zones can also be managed real-time in a dynamic process.
- Elevating vital functions. the refuges and transportation networks, as center parts of the evacuation process, should be protected against the water rise by being elevated above the level of adjacent ground.
- In the same time, one should as much as possible concentrate non essential functions or flood-resistant infrastructures on the ground level in the flood-prone zones, while living quarters have to be elevated above the expected level of water. Of course this might not be always possible, but one should keep this principle in mind when designing new urban quarters.

REDUNDANCY: OVERLAPPING FUNCTIONS; IF ONE FAILS, OTHERS CAN TAKE OVER.

Application to Insurance programs:

- If insurance companies fail, the government or the EU intervenes with regard to residents and businesses (can be both in contracting and in reimbursing).
- Possibility for people to contract with different insurance companies.

- Include coinsurance clause or high deductable on insurance policy in case of moral hazard situation.
- Insurance companies offering the possibility of both individual and group/cooperative contracts (pool the risk option) for businesses, households or communities.
- International organization and NGOs alarm systems that can help if the government fails.
- At bigger scale insurance market may offer the possibility to participate in both multi-country and national "risk pool" policies so if one fails the other could counterbalance effects.
- Coexistence of insurance coupled with regulation and standards policies.

Application to spatial planning:

- Not identified.

Application to business disruption and recovery:

- Alternative sources of supply of the usual inputs to the business: raw materials. This can mean that business can continue even during hazard events, or resume rapidly after the event has passed. Customers are retained.

Application to Post-crisis response:

- Multiple routes (roads, ferry services, etc.) into and out of the area.
- Buildings could have multiple access. Vital functions (housing, hospitals, etc.) should have counterparts outside the area as well

Application to risk communication:

- Relying on all medias, including informal information sharing through social networks that ARE NOT necessarily ICT based.
- Relying on participatory processes.

Application to Evacuation plans:

- Making the system redundant thus means that there are several refuges available, several safe locations inside or outside the city, several sources of primary needs (food, water) secured by contracts with suppliers. These properties give a first insight of the quality criteria an evacuation plan has to honour. A methodology should lead to such an evacuation plan and each part of it has to deal with one of those aspects.

ELEMENT CONNECTED WITH RESILIENCY BUT NOT CLEARLY ASSOCIABLE WITH THE ABOVE PRINCIPLES

Other considerations for spatial planning and business disruption and recovery: the area should have clear — and clearly communicated —contingency planning, strategies for managing risks, vulnerabilities, river and water, supplies and storage, et cetera. Participants suggested segmenting or categorising the area into sub-areas, depending on the vulnerabilities, and tailoring policy options to these sub-areas..

SECOND COHERENCE BUILDING FRAMING: SPRC AND THESEUS' WP5[9]

RISK GOVERNANCE AND SPRC

Within THESEUS, a key challenge for generating governance based risk mitigation options lies into the fact that governance does not necessarily lends itself well to the structuring properties of the SPRC model. One could easily argue that SPRC modelling and risk governance in the face of complexity and uncertainty are epistemological opposites (representing in a deterministic quasi linear framework a highly complex deeply uncertain process).

Furthermore, fieldwork with stakeholders seems to indicate that for governance body the sequences is inverted (see ID1.5). What matters first in the cognitive process of stakeholders seems to be the C of "Consequences," then stakeholder move "up" the SPRC causal chain. As such offering governance based options within an underlying SPRC sequence, in that order, does not lends itself well cognitively.

Finally, Source, Pathway, Receptor and Consequences are quite polysemic concepts. The categorization depends necessarily the way the object is construed by stakeholder. A dyke may be the hunter's receptor and the farmer's pathway in France polderized marshlands. The burden of some of the consequences may be shifted to stakeholders who are not clearly aware of this (public insurance funded by taxpayers, the final "Consequence" being public deficit).

In order to address these challenges, it was decided to be explicit of the potential connection and misses that the combination of an underlying SPRC model based DSS and governance options may entail. By choosing this route not only will allow for increased intra work package coherence and for increased inter work package coherence, particularly between WP4 and WP5.

In the course of each of WP4 WTs a constant exploration of the potential linkages with the SPRC framework must be undertaken and rendered explicit.

Box 5: fifth recommendation regarding the development of WP4 overarching framework, making SPRC workable in a risk governance framework

ADDRESSING THE SPRC – RISK GOVERNANCE NEXUS THROUGH REFLEXIVE QUESTIONING

A first set of four questions, for each WT and for the overarching framework, are dealing with the concepts of source, pathway, receptor and consequences:

1. Are the mitigation options that we are exploring dealing with qualitative changes with the nature of the source?

2. Are the mitigation options that we are exploring dealing with qualitative changes with the nature of the pathway?

3. Are the mitigation options that we are exploring dealing with qualitative changes with the nature of the receptor?

4. Are the mitigation options that we are exploring dealing with qualitative changes with the nature of the consequences?

A second set of three questions are dealing with the concept associated with exposure to risk, closely associated with the perception of risk envisioned here as the combination of pertinence, causal and normative claims:

1. Are the mitigation options that we are exploring dealing with the issues of pertinence claims and as such change the level of exposure?

2. Are the mitigation options that we are exploring dealing with the issues of causal claims and as such change the level of exposure?

3. Are the mitigation options that we are exploring dealing with the issues of normative claims and as such change the level of exposure?

THIRD COHERENCE BUILDING FRAMING: BEYOND CURRENT CONCEPTS

SHOCKS AS OPPORTUNITY FOR GROWTH

As proposed by the Middlesex Flood Hazard Research Centre team, we have to take into account current emerging frameworks:

1) Impacts and recovery are differently driven, the former by private effects, and the latter by social processes;

2) Social learning must be explored as a mean to foster adaptation as a growth process;

3) We have to consider that resilience is not always a good thing: sometimes change is desirable;

We should thus, throughout WP4 improve current knowledge by paying a particular attention to two concepts: social capital as complex and important aspect of adaptability and learning as a key component of adaptability.   This is the purpose of the third integrative framework that is construed as an emergent characteristic of THESEUS' WP4.

The first key question we need to explore is : How do we move to a more desirable (changed) state after a shock?

This will entail the following elements:

Integrating social learning as part of the crisis and post crisis management systems;

Building integrated scenario of change in order to equip mentally communities with alternatives;

Being careful to the fact that a return to initial state may be the only option;

Equip communities with our concepts in order to allow for local social change - we need to "pragmatize" our concepts;

Open "windows" on a more desirable in the interview process – through visioning for instance;

And more importantly accepting that whatever we develop, its implementation will be extremely context dependant.

COMPLEX SYSTEM ANALYSIS

We have to move integrating several perspectives related with each WT: Insurance program - Land use planning - Business recovery - Post flood trauma management - Communication of science – Evacuation. As was mentioned during the WP4 workshop and further meetings we need to dovetail these approaches in a way that is mutually reinforcing while being conceptually coherent and: take into account the main participants considerations, we have to:

1. Move beyond the current paradigms in order to develop tools that are pertinent to the new challenges associated with the complex nature of the process under scrutiny.
2. Take into account climate change and its epistemological uncertainties
3. Take into account University of Bologna team meta-analysis work we have to figure out the way to combine the terms of: "flood" and "mental health", "well-being", "stress" and to work into inclusion of a criteria of a clear measure of a mental health.
4. Moving toward the integration of personal heuristic, social interactions, scientific information and technological development;
5. Moving from Knowledge Quality Assessment to Technology cum Knowledge Quality assessment.

6. Qualifying, through extended peer review, technological development in a way that takes into account for local pertinence and normative claim.

Throughout WP4 a particular attention should be given to the opportunity to move beyond current concepts and practices. A particular focus should be given to the opportunity for aftershock growth and to the opportunity to apply complex system thinking to the development off pragmatic mitigation options.

Box 6: Sixth recommendation regarding the development of WP4 overarching framework, taking the unique THESEUS opportunity to move beyond current concepts in terms of flood and erosion risk governance

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