Project number: 265138
Project name: New methodologies for multi-hazard and multi-risk assessment methods for Europe
Project acronym: MATRIX
Theme: ENV.2010.6.1.3.4
Multi-risk evaluation and mitigation strategies

Start date: 01.10.2010  End date: 30.09.2013 (36 months)
Deliverable: 6.3 Social and institutional barriers to effective multi-hazard decision making
Version: Final
Leading partner: IIASA (International Institute for Applied Systems Analysis)
Contributing partners: BRGM (Bureau de Recherches Geologiques et Minieres)
AMRA (Analisi e Monitoraggio del Rischio Ambientale - Scarl)

Month due: 24  Month delivered: 33

Authors: Anna Scolobig, Charlotte Vinchon, Nadejda Komendantova, Mendy Bengoubou-Valerius, Anthony Patt
Contributors: Paolo Gasparini, Angela Di Ruocco, Audrey Baills, Arnaud Revellière
Reviewers: Fabio Sabetta (Italian Civil Protection), Daniel Monfort-Climent (Bureau de Recherches Geologiques et Minieres), Kevin Fleming (Helmholtz-Zentrum Potsdam Deutsches GeoForschungsZentrum), Gordon Woo (Aspinall Consulting Ltd)

Reviewers:  
Signature  Date

Authorised: Jochen Zschau  24.06.2013
Signature  Date
<table>
<thead>
<tr>
<th>Dissemination Level</th>
<th>Description</th>
<th>PU</th>
<th>PP</th>
<th>RE</th>
<th>CO</th>
</tr>
</thead>
<tbody>
<tr>
<td>PU Public</td>
<td>Public</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PP Restricted</td>
<td>Restricted to other programme participants (including the Commission Services)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RE Restricted</td>
<td>Restricted to a group specified by the consortium (including the Commission Services)</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO Confidential</td>
<td>Confidential, only for members of the consortium (including the Commission Services)</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
Summary

Multi-type hazard and risk assessment methods allow for the taking into account of the dependencies between different risks, by using harmonised procedures based on common metrics. Before new methodologies (as developed in other Work packages of the MATRIX project) are implemented into existing risk management systems, not only the technical, but also the social and institutional consequences need to be taken into account.

The deliverable D6.3 of the MATRIX project reports on research about the social and institutional barriers to effective decision-making and governance in the case of multiple hazards. To better understand these barriers, the deliverable first assesses the current situation by describing the general architecture of risk management regimes and by profiling the key characteristics of risk governance within diverse natural hazard contexts. This forms the basis for the description of the strengths and weaknesses of existing risk governance systems, as well as the institutional benefits and barriers to effective multi-risk governance.

The core of the research work is a comparison of two case studies: the city of Naples (Italy), and the department of Guadalupe (French West Indies), both of which are exposed to multiple hazards among which earthquakes, volcanic eruptions, landslides, floods, tsunami, cyclones, erosion, marine inundations, fires and pipeline breakages. The research design included a literature review, a desk study of legal, regulatory and policy documents, twenty-nine semi-structured interviews with local stakeholders and a focus group with experts and researchers.

The results provide an overview of institutional and legislative settings for risk governance across different natural hazards in Naples and Guadeloupe. This is followed by a comparative evaluation of risk governance which covers matter of i) tools and plans available for risk management, ii) governance level and scale, iii) stakeholder cooperation and communication. This evaluation allows for identifying similarities and differences across risks and countries, as well as strengths and weaknesses in the current systems. For example among the strengths we can mention the integration of hazard/risk and urban planning in Guadeloupe or the widespread availability of hazard assessment in Napoli. The low financial capacity at the local level is instead a common weakness. The analysis reveals a general tendency in both countries to focus on the technical aspects, with less attention paid to risk communication and multi-stakeholder involvement in decision-making.

The results of the comparative analysis show how addressing multiple hazards/risks can lead to considerable institutional improvements in the efficiency of risk and emergency management. At the same time, the results illustrate the institutional barriers to the adoption of these methods that are related, for example, to the division between the communities of geological and meteorological practitioners. Due to the different educational and professional development paths, the support tools and decision-making processes – and even the language used – for geological hazards has evolved differently from meteorological or technological hazards. In Naples, the difficulties in interagency communication for hazards managed at different levels (e.g. national vs. regional), the scarcity of public/private partnership, the lack of an emergency plan with information about multiple hazards and risks, and the research-practice divide represent serious threats to the implementation of multi-hazard and multi-risk approaches. In Guadeloupe, other barriers are relevant, such as insufficient supra-regional risk governance, the conflict between the cultures of safety and economic development, and a partial understanding of vulnerability and prevention. The deliverable ends with a discussion on the key findings, including the implications for the present debate on new multi hazard and risk assessment methods.
Acknowledgments

The work described in this deliverable was supported by the European Community’s Seventh Framework Programme through the grant to the budget of the MATRIX project [FP7/2007-2013] under grant agreement n° 265138. The deliverable reflects the authors’ views and not those of the European Community. Neither the European Community nor any member of the Matrix Consortium is liable for any use of the information in this deliverable.

We wish to thank all the colleagues and persons who provided us with professional advice and collaboration. We are grateful to all of them and especially to the interviewees who spent their precious time to discuss with us the complex architecture of risk governance in Naples and Guadeloupe.

Notes

Authors’ contribution: Anna Scolobig, Nadejda Komendantova and Anthony Patt from the International Institute for Applied Systems Analysis (IIASA) scoped and planned this deliverable and wrote the Italian sections, with contributions by Paolo Gasparini and Angela Di Ruocco (AMRA). Charlotte Vinchon and Mendy Bengoubou-Valerius (BRGM) wrote the French West Indies sections, with contributions by Audrey Baills and Arnaud Revellières (BRGM).

Submission: The Deliverable 6.3 submission was delayed to month 33 due to the West Indies cyclonic season, which prevented the start of the fieldwork on time.
Introduction

The main purpose of Task 6.3 of Work package 6 “Decision support for mitigation and adaptation in a multi-hazard environment” of the MATRIX project is to identify social and institutional barriers to effective decision-making in the case of multiple hazards, and to propose options for overcoming them. The starting point is that policies and decisions for mitigating and adapting to hazards are taken within an institutional context characterised by the presence of multiple agencies working to provide a vast array of decision support tools. Yet, decisions are not taken in a hypothetical world populated by rational actors free of institutional incentives, but rather within a context marked by divisions of responsibility, poor communication pathways and at times conflicting objectives. These and other factors could create a particular burden on the use of multiple-hazards assessment.

This deliverable focuses on social and institutional barriers and it represents a major outcome of Task 6.3. It summarises the main findings of two real world test cases, one in Italy (Naples), and one in the French West Indies (Guadeloupe). It relies on a desk analysis of legal and regulatory documents, leading into stakeholders’ interviews and experts’ focus groups.

The deliverable consists of three main parts:

- **Synthesis**
- **Report Italy/Case study Naples (Annex I)**
- **Report French West Indies/Case study Guadeloupe (Annex II)**

The synthesis has a common background setting out the main concepts and the methodological approach. These sections are followed by a presentation of the hazards under study in Naples and Guadeloupe and an overview of the relevant national organisations, including the administrative structures and the general approach for risk management. The empirical results about the risk governance systems are presented afterwards. The last section focuses on cross-national comparison, lessons to be learned from the different case studies, benefits and barriers to effective decision-making in the case of multiple hazards, and the first identification of the options that may be used to overcome these barriers (which will also be used as inputs for the Task 6.4 deliverable D64 “Synthesis: Benefits and barriers to multi-hazard mitigation and adaptation, with policy recommendations for decision-support”).

Annexes I and II constitute the background documents for the synthesis. They present an overview of natural risk management in Italy and France. Their structure is as far as possible similar, although some research questions are focused in more detail in certain sections, because they arose out of the specific context of the case studies.
1. Background

1.1 Multi hazard and risk assessment

Multi-hazard and risk assessment methods

A variety of natural extreme events, including river floods, landslides, volcanic eruptions, tsunamis, winter storms, wildfires, earthquakes, and coastal phenomena threaten different regions in the world. In the majority of cases, planners and policymakers, as well as scientists who inform their judgment, treat the hazards and risks related to such events separately from each other. This might fail to recognize cascading and conjoint effects of different hazards. For example, an earthquake may trigger a tsunami, which may in turn damage flood defences, pipelines or industrial sites. Multi-hazard and risk assessment methods allow the taking into account of the dependencies between different risks, by using homogeneous procedures based on common metrics. The assessment of differential spatial patterns of risk and the quantification of potential total risk allows the comparison of different types of risks and their return periods (e.g., Marzocchi et al. 2009; Garcia-Aristizabal et al. 2013).

As mentioned above, multi-hazard and risk assessment take into account conjoint and cascade effects. By conjoint effects, we mean a series of parallel adverse events generated by different sources, for example, heavy tropical rain during an earthquake. Cascade happens when an adverse event, located inside or outside the site, triggers one or more sequential events, such as heavy rains and landslides (ibidem). In addition, the occurrence of a given hazard may not only cause additional events via cascade or domino effects, such as earthquakes triggering tsunamis, or volcanic eruptions triggering earthquakes. An event may also increase the vulnerability of the region or the country to hazards in the future. The conjoint and cascade hazards can be approached by a multi-risk assessment, which should improve our ability to take risk reduction measures in a cost-effective way and to lower the consequences of these events.

When assessing multi-hazard and risk, there is a need to identify comparability between the different types of risks, cascading hazards, and time dependent vulnerability within the framework of conjoint or successive hazards. Currently, evaluations of risks related to different sources are mainly conducted on the basis of single risk analysis and the multi-risk analysis is most often provided as a sum of such assessments. This may lead to a high uncertainty in the estimation of the real risk because of two reasons: (i) the single risk assessments are not always adapted for inter-comparison because they deal with different spatial and temporal resolutions and use different approaches to vulnerability; (ii) the single risks sources are rarely strictly independent. Single risk approaches make it difficult to compare risks with such an implicit assumption of independence of the risk sources. This leads to a neglect of possible interactions among the risks and “cascade” effects, when the risk to and vulnerability of exposed elements may change significantly after the occurrence of an event.

Multi-hazard and risk case studies

To better understand how these methods are used, we report some examples of good practice in developing quantitative methods of analysis for multi-hazard situations, allowing quantitative assessments and enabling their comparison on the bases of risk indicators.

Possible procedures for multi-hazard case study were developed within the framework of the Principles of Multi-Risk Assessment, Interaction among Natural and Man-Induced Risks (NaRaS project for the Casalnuovo municipality). Casalnuovo, a municipality in southern Italy, is located just 13 km away from the crater of the mount Vesuvius volcano and is
exposed to several kinds of hazards, like the Vesuvius volcano, the Irpinia tectonic earthquake source, a river passing through the municipality, as well as the presence of industrial landfills. The local government was interested in identifying the most dangerous hazards and the most effective way of financing risk mitigation measures. The multi-risk assessment provided local decision-makers with new insights into the mitigation of hazards. It showed that volcanic risks overwhelm significantly all other risks in terms of mitigation measures, and that interactions between volcanic, industrial and environmental risks are not taken into consideration, which leads to an underestimation of these risks. However, this project did not consider the barriers in the institutional structure, which would also provide operative guidelines for the implementation of multi-risk assessments (Marzocchi et al. 2009).

Another multi-risk assessment was conducted for the city of Cologne by the German Research Network Natural Disasters project (e.g. Grünthal et al. 2006). The vulnerability of Cologne is marked by the huge accumulation of human as well as cultural, industrial and economic assets. The city is exposed to windstorms, floods and earthquakes. The multi-risk assessment included vulnerability assessments and estimation of direct losses for such sectors as private housing, commerce and services, industry, energy and water supply. The project also developed a set of scenarios focusing on potentially damaging events from each of three above-mentioned types of hazards. The Cologne project conducted a detailed assessment for multi-risk situations, but did not investigate the consequences of interactions between the hazards, no the institutional structure existing in the city of Cologne; this impeded efforts to proceed further in mitigating and managing these hazards.

These case studies point out the need for an analysis of decision making and governance aspects, including the identification of roles, capacities and interactions of separate stakeholders and organizations. It was identified by the GEO Disasters Societal Benefit Area as a target for 2015, including increased communication and coordination between national, regional and global communities, in support of disaster risk reduction, based on the clarification of roles and responsibilities of every involved institution and therefore as a result, improved resources management.

**Task 6.3 case studies**

Several other work packages of the MATRIX project describe in detail multi-hazard and risk assessment concepts and methodologies (WP 3). In Guadeloupe, cascade/conjoint risks are illustrated in a scenario (WP 4) close to the earthquake of November 2004, which occurred conjointly with heavy tropical rain, increasing the landslide susceptibility. The scenario considers a similar event, and different ground acceleration compared to different soil water saturation conditions. Induced landslides are assessed on how they are likely to cut and disrupt the island’s lifelines, depending on the events’ intensity. Beside the scenario of WP4, single events (earthquakes and cyclones) are quantified by the cost of damages they have (e.g. earthquake of les Saintes 2004) or could induce, hence allowing a comparison of both risks.

In Italy, the case study is Naples and 3 different areas of the city have been selected for the test cases: Camaldoli (landslides, earthquakes and forest fires), Arenella (earthquakes and ashfall) and Fuorigrotta (earthquakes vent opening, volcanic eruption, ashfall, pyroclastic flows and ground deformation).

These case studies are presented in more detail in the deliverables of workpackage 7 of the Matrix project, namely D7.3 “Naples test case” and D7.4 “French West Indies test case”.
1.2 Decision making

The direct benefit to society, in the form of improved decision-making under conditions of uncertainty, is the raison d'être of all manners of risk assessments and multi-risk assessments would be no exception. At the same time, a critical part in any risk or hazard assessment is the challenge of linking the information from analysis to policy and decision-making. There is a growing literature documenting best practices in this field for single hazards, but the same is not true for multiple hazards. One key challenge relates to the extent to which conducting integrated assessment of multiple hazards compared to single hazards separately may improve decision making outcomes.

There are many reasons to believe that multiple risk assessment can lead to better decision-making outcomes. Benefits will derive from the fact that this assessment may allow one to establish a hierarchy of risks, with the help of quantifying and comparing different types of risks. It can also identify areas where efforts to mitigate against one hazard may conflict or create synergies with the planned adaptation and mitigation activities for a second type. It can also suggest how the severity of hazards, and the resources required for their mitigation, may be higher than anticipated.

Multi-hazard risk assessment may emphasize, for example, that efficient mitigation actions do not necessary need to be focused on the reduction of the highest risk, but on the risks that could be most reduced and lead to relevant policy implications.

Addressing multiple hazards may lead to a significant cost reduction and an improvement in the efficiency of risk mitigation and management measures, in comparison to cases when hazards are treated separately from each other.

Finally this approach may help develop a better coordination and interfacing between different specialized authorities and agencies who deal with specific hazards or risks without developing an overview of the knock-on, domino and cascading effects.

At the same time, the use of multi-risk assessment may require the cooperation of multiple agencies, making it even more challenging to produce a useful product for decision-makers for a number of reasons. For example, the transfer of these methodologies may encounter a barrier, due to the existing organisation of risk management, where responsibilities are dispersed, and communication insufficient between the organisations in charge, with, at times, conflicting objectives.

In current practice also, due to the lack of resources, concrete actions often rely on one or a few persons. This procedure may be harshly criticized if - a posteriori - these mitigation actions turn out to be perceived to be wrong. Hurricane Katrina is a good example of such dysfuntionality in decision-making. For example, before and during the hurricane, the mayor of New Orleans personally managed the scientific input. He called the evacuation very late, because he was worried that the city could be sued if a mandatory evacuation turned out to be unwarranted (Woo 2011).

Institutional factors are also important. In the case of a single hazard, Cash et al. (2006) demonstrated the importance of linking hazard information to the actual needs of decision-makers, and how different institutional designs achieve this more effectively than others. To enable inter-agency collaboration in the management of linked risks, Patt et al. (2005) document the necessity of establishing not only clear communication pathways, but also formal accountability for the process of using data generated in one agency to improve decisions made in a second.

Finally, social factors also need to be taken into account. This may involve considering different risk perceptions of individuals or agencies who view the goals and objectives of hazard management differently (Verweij and Thompson 2006): successful decision support tools may provide a basis for people to reach a consensus, or at least a compromise, in terms of the actions that are to be taken.
1.3 Risk governance

Good governance is identified as particularly important to support actions at several levels – from local to international-, to identify and reduce risks, to deal with emergencies and disasters effectively and to foster an integrated approach for risk reduction in policies, planning and programs related to sustainable development (Hyogo Framework 2005; UN-ISDR 2005; IRGC 2007, ISDR 2009, 2011).

At the same time lack of governance may result in high human and economic losses in case of natural and man-made disasters. One recent example is the accident of the Fukushima Daiichi power plant, in 2011, which has been defined as the result of a governance failure among the government, the regulators and the private plant operators (Aa.vv. 2012). As reported by the nuclear accident independent investigation committee, the root causes have to be found primarily in “the organizational and regulatory system that supported faulty rationales for decisions and actions” (reported in Funabashi and Kitazawa, 2012: 5).

But the question is: what is really governance and why it has become so important? In recent years, governance has become a "buzzword" applied in distinct contexts in order to describe and explain almost everything. Walker et al. (2010) presented 10 more or less different definitions of governance and they pointed out the negative consequences of these multiple definitions on the operationalization of the concept.

Throughout this document, we embrace the definition of the Commission on Global Governance and consider governance as “the sum of the many ways individuals and institutions, public and private, manage their common affairs. It is a continuing process through which conflicting or diverse interests may be accommodated and co-operative action may be taken. It includes formal institutions and regimes empowered to enforce compliance, as well as informal arrangements that people and institutions either have agreed to or perceive to be in their interest.” (Commission on Global Governance 1995: 2). In other words, governance pertains to formal institutions empowered to enforce compliance, as well as informal arrangements, that stakeholders either have agreed to or perceive to be in their interest (Renn 2008).

We add to this general definition of governance an aspect which is particularly relevant in the case of natural risks, i.e., that governance covers all phases of the disaster cycle from risk pre-assessment, characterisation/evaluation, appraisal, management and communication (IRGC 2007).

To better understand how to analyse and operationalize risk governance, we discuss some key points related to the debate on this concept.

Governance and government

As already partially revealed by the definition reported above, governance, as opposed to government, allows the emergence of new forms of authority and communication, the involvement and collaboration of a multiplicity of stakeholders in risk decision making, multi-level processes, as well as a changing distribution of responsibilities between the state and other actors (Walker at al. 2010; Komendantova et al. 2012).

Governance level and scale

Governance includes a diverse and interdependent set of stakeholders working at different levels, from the national to the local one, as either public, private or voluntary actors. Rhodes (1997) describes governance as a situation where there are no longer single (state) authorities, but a multiplicity of actors, specific for each policy area, which may have shared goals despite the fact that they come from different sectors. This may result in new forms of actions, interventions and control (Bevir and Trentmann, 2007). It is important to note that management of natural hazards has always involved the activities of multiple actors. This is
particularly obvious in emergency response where coordination between multiple public services, voluntary and community organisations is typically involved. This characteristic is useful for the study of multiple risks because it allows, for example the identification and comparison of different systems with regard to their degree of centralisation (vs. decentralisation) or the role of the private sector.

**Culture of multi-stakeholder participation in decision-making**

In the European context, several laws and directives clearly support a participatory approach (e.g., Water Framework Directive 2000/60/EC). With regard to natural hazards, the European Flood Directive (2007/60/EC) clearly calls for participation of the public: “Member States shall encourage active involvement of interested parties in the production, review and updating of the flood risk management plans...” (art.14). Stakeholders' involvement in decision-making can often bring new options to light, such as allowing the taking into account of local concerns and to delineate the terrain for agreement or compromise, adding to the credibility of institutions dealing with risks, ensuring the transparency of the democratic process and support for decisions taken, and the sharing of responsibilities between public and private actors (Rowe and Frewer 2005, Renn, 2008, Scolobig et al. 2012). Of course, participation is not a panacea and there are many problematic issues related to the implementation of these processes such as dilemmas of inclusion/exclusion of participants, the struggle to define the boundaries of what instances, groups, knowledge, values, and behaviours, are relevant for the purposes of the process, the methodologies to adopt, etc. Another crucial problem concerns the legitimization and, more precisely, the ways to transfer the legitimacy gained by decisions from the groups and constituencies involved in the participatory processes to the groups that have not been involved and especially to the actual decision making arena (Loefstadt 2004, Rowe and Frewer 2005, Renn, 2008).

**Shift of responsibility away from the state**

Shifts of responsibility have been associated to some degree with a shift from an approach based upon mitigation to one focused upon adaptation, where the goal is to help people live with and recover from the impacts of events (Walker et al. 2010). For example, within the UK such approaches are enshrined in the strategy “Making Space for Water” (Defra 2005) as well as in recent policy initiatives that encourage householders and businesses to reinforce their buildings to be more resilient. This shift can be interpreted as a split between the steering elements of governance, with government continuing to set flood policy, while at the same time seeking to shift responsibility for costs to other segments of society (Watson et al. 2009).

**Risk communication**

This characteristic relates to the exchange of information and knowledge among decision makers, risk managers, public authorities, companies, and towards the general public. It is an interactive exchange rather than a one-way transfer of information, and serves different purposes, modes and tools and conveys different messages. In the field of natural hazards, communication is vital before, during and after an event. It may have different aims such as to raise awareness, to encourage specific protective behaviour, to inform about hazard-risk assessment, to keep memory alive, announce emergencies, to inform about warning procedures, implement recovery measures, share information and knowledge among agencies etc. (e.g., Hoppner et al. 2010; Frewer 2004; Steinführer et al. 2008).

From a managerial perspective, risk communication has been enshrined as a fiduciary responsibility of official bodies in a number of European and international policy documents and is a building block to reach the objectives of a more effective governance (e.g. Rio Declaration, 1992; Aharus Convention, 1998; Water Framework Directive 2000/60/EC; Flood Directive, 2007/60/EC). These documents have been translated into national laws and regulations (see Wright et al. 2006). It is important to note that although guidelines on the communication of technological, chemical, food and health risks have emerged, there is hitherto no generic document that specifically sets out legal requirements or
recommendations on the communication of natural hazard related risks at the European level or transborder risks.

2. Research design

Desk study

The research work started with a desk study of legal, regulatory and policy documents at national level. This work aimed to build the skeleton of the risk governance system by taking into account laws, policy documents, reports, academic papers, journalist commentary, websites, etc.

As a result, we obtained a description of the distribution of tasks and responsibilities in the different disaster cycle phases from risk assessment and forecasting to prevention and alerting/early warning, emergency management and relief, and recovery and reconstruction, including education and communication initiatives. The analyses of the two case studies included different levels, from the national to the regional, district, provincial and municipal one, also depending on the countries’ administrative structure and legislation. The structure of the analytical framework is as far as possible similar, although some sections of the deliverable provide more details on relevant issues specific to each case study. In a second stage we focused on the differences in the risk governance across the natural hazards/risks considered. More precisely the considered hazards were earthquakes, volcanic eruptions (including ash fall, lava flows, lahars, pyroclastic and tephra flow), hydro-geological hazards (including landslides, floods, high intensity rain), fire, heat waves, cyclone, tsunami, marine inundation, erosion, pipeline breakages. In spite of the geographical distance between the two case studies (more than 7,000 km), they are exposed to similar types of risks, though with different characteristics. In contrast with Naples, the French overseas department of Guadeloupe (Département-Région d’Outre Mer) is prone to cyclones, and induced inland floods and marine inundation.

Interviews

To validate the results of the desk study, identify the social and institutional barriers to effective decision-making in the case of multiple hazards, and propose initial options for overcoming them, we conducted stakeholders’ interviews on the basis of a protocol, which we developed after the literature review (Annex III and IV). Based on a short description of the MATRIX project and specific actions in Italy/Guadeloupe, the protocol was divided into 3 main parts, framing the role of the interviewees’ organisations/agencies in risk management, asking their opinion on present-day single risks management, and on the potential benefits and barriers to multi-hazard/risk management. The questionnaires were adapted to the specificities of each case study.

We interviewed face to face 21 stakeholders in Naples and 8 in Guadeloupe, i.e., people who, due to their status, role or experience, have a deep knowledge of the subject under investigation and/or the relevant context: officers/directors of civil protection and fire brigades corps at different levels (from national to local); officers responsible for hazard/risk assessment, urban planning and emergency management, directors of research institutes, university professors, etc. The list of interviewees is reproduced in Annexes III and IV.

In Italy, each interview was audio recorded and lasted for about 1 and 1 ½ hour. Subsequently, we revised the notes, transcribed the tapes and submitted the final version to the interviewee for approval. As a result, the transcripts were checked with the informants who sometimes suggested changes or added new information.

In Guadeloupe, interviews were scheduled for October 2012. However, during the 13-15th of October 2012, the tropical storm Rafael hit Guadeloupe. It induced numerous small landslides and flooding, with one fatality due to flood. This caused a situation when fewer
organizations were interviewed as originally planned. Interviews lasted for about 1 to 2 hours, and are synthetized in the tables enclosed in Annex IV.

Data analysis and feedback

The data collected were analysed by identifying recurrent themes, key concepts and analytical categories. In the following chapters, we will largely use extracts of the interviews as illustrations of a point and as supporting evidence for an argument.

We also organized various feedbacks to check and validate the accuracy and quality of the preliminary results. More precisely we: i) presented and discussed key findings during a MATRIX project meeting with other partners with working experience in the countries under study; ii) returned to key stakeholders for a second round of interviews to validate the results.

Comparison

In the course of the Task 6.3, we were faced with the methodological challenges of cross-country comparison, along with their added value and limitations. With the on-going internationalisation of research – in Europe strongly encouraged by the funding policy of the European Commission – questions of cross-cultural research methodologies are becoming increasingly important in different fields and disciplines (just to mention some examples in the social science sector: the European Social Survey (ESS), the International Social Survey Program (ISSP), the European Value Survey (EVS) or the Eurobarometer, Steinfuherer et al., 2009, Harkness 1998, 2006, Grözinger et al. 2007).

However, while comparative analyses are frequently demanded, they are even more often challenged and criticised – be it their theoretical and methodological background, the criteria for the selection of case studies, the interpretations by the researchers, or the general comparability of institutional structures and processes. Beside cross-cultural differences, a final issue of research cooperation needs to be mentioned. In such a task as undertaken and outlined in this work, it is impossible to agree on all issues and to always find a compromise. Hence, different theoretical conceptualisations, empirical interpretations and practical conclusions belong to the work described below. Thus, there are certainly contradictory descriptions and explanations left also in this deliverable, but one must keep in mind that it was written by 9 different authors from 5 different countries with 6 different disciplinary backgrounds (and many more differentiations, e.g., with respect to regional background, gender, age, disciplinary training etc., could be added).
3. Case studies

3.1 Italy (Naples)

In the period 1998-2009, Italy mourned more than 20,000 fatalities due to natural catastrophes (EEA 2010). In terms of fatalities, all over Europe the country is second only to France. In the last two decades (1990-2010) the overall costs for natural disasters have been estimated to be approximately 100 Euros billion (Monti and Chiaves 2006).

Hydro-geological risks represent the most frequently occurring natural hazard in the country. Over the last 80 years, there have been as many as 5,400 floods and 11,000 landslides and avalanches. About 5 million inhabitants are in areas of a very high landslide and/or flood risk. More than 10,000 people have died from hydro-geological related causes in the last century and more than 350,000 remained homeless or had to be displaced (Sabetta, 2012, Sabetta and Lo Presti 2012).

Regarding earthquakes, up to 38% of the Italian population (i.e. about 23 million people) live in highly seismic areas (zone 1 and 2) where 60% of the buildings are not constructed according to anti-seismic rules (Sabetta and Lo Presti 2012). Since 1000 A.D., nearly 30,000 events have occurred while during the last two centuries, earthquakes have caused about 160,000 deaths and have damaged and/or destroyed a great deal of historical and artistic heritage, whose value is not quantifiable.

There are several active volcanoes present on the national territory. Almost 2 million people all over the country are exposed to volcanic hazard: Etna 1 million people, Vesuvio 600,000 people, Campi Flegrei 250,000 people, Vulcano 15,000 people (in summer).

The forests cover 10 million hectares or one third of Italy; 60% of the forests are privately owned and 40% are public property. Every year, thousand hectares of the national territory burn as a result of several causes, related also to anthropic factors. For example, in 2010, 88% of forest fires were caused by human activities (both voluntary and involuntary), with 11% of unknown cause and 1% natural, while during the last 30 years, 12% of the national forest has been destroyed because of fires.

Besides the risks related to natural hazards, some areas of the Italian territory are also prone to the risk of industrial accidents. Industrial accidents are defined by European legislation, in particular by the Seveso II Directive 96/82/EC, as amended by 2003/105/EC on the prevention and mitigation of major industrial accidents. However, an issue not covered by the Seveso Directive that poses a major industrial-related risk concerns pipelines outside establishments (e.g., pipelines for oil or natural gas transport). Damages to pipelines can be not only human-induced, but also NATECH accidents, i.e., industrial accidents triggered by natural hazards, such as earthquakes, landslides or forest fires. With regard to pipeline breakages outside industrial establishments, the Gas National Committee provides guidelines for the preparation of emergency plans. Protocols of actions are different depending on the type of event, defined, respectively, as first aid, gas accident, or emergency, depending on the scale. The emergency plan contains detailed instructions on the actions to perform and the officers in charge in case of different scenarios, such as breakages inducing fires, gas dispersion, etc. (Città della Scienza 2008).

Naples, the selected case study (Fig. 1), is exposed to all of the above listed natural hazards. Naples is capital of one of the 5 provinces of the Campania region, in the southern part of Italy. The city has almost one million inhabitants (957,012, ISTAT, 2012) and has an area of 117 km². It is definitely a multi-hazard and risk environment.
First of all, earthquakes caused by both the Apennine chain tectonic seismic source and the Campi Flegrei and Somma Vesuvio volcanic sources can be felt in Naples. Moreover, landslide phenomena involves both the steep welded volcanic rock slopes of the hills bordering the city and the looser pyroclastic covers (compacted ash) emplaced by more recent volcanic activity. The Neapolitan Yellow Tuff, a soft welded pyroclastic rock, which makes up most of the Naples subsurface, in the past was intensively exploited by man and now is crossed by a network of tunnels and subterranean galleries whose roofs often collapse. Flood events are very frequent as well, due to the geomorphology of the city, which mainly lies on narrow coastal plains bordered by pyroclastic hills, whose slopes quicken the flow of sediment-laden waters toward the sea (Alberico et al. 2011). In the last few years, severe forest fires have been reported in the city of Naples, mainly during the summer period, for example more than 40 forest fires were registered in 2011 (Department of Agricultural, Campania Region 2012). Mostly, these fires had anthropogenic causes and affected the green areas of the city. Several industrial plants are concentrated in the eastern part of the city and a natural gas network crosses the whole city. Because of a relevant exposure to several natural hazards, the occurrence probability of a NATECH event in the city of Naples cannot be neglected (see Annex I).

The figure below (Fig. 2) represents how the hazards considered for the risk governance analysis in the Naples case study are interrelated and what are the possible cascade effects in a multi hazard perspective. Additional information may be obtained from the MATRIX WP 3 deliverable D3.3 “Scenarios of Cascade Events” (García-Aristizabal et al. 2013).
Figure 2: Relationships between different hazards considered for the risk governance analysis in the Naples case study (the arrows are orientated in the direction of triggering)

3.2 French West Indies (Guadeloupe)

Guadeloupe archipelago (Fig. 3) is one of the 5 overseas French territories (Département-Région d’Outre Mer) located in the West Indies. It is under French national and local administration system with the specificity of having both regional and departmental collectivities within the same territory.

Guadeloupe gathers 5 main islands: Grande-Terre, Basse-Terre, Marie-Galante, la Désirade and Les Saintes. It represents an area of 1 628 km² and 32 municipalities.
Natural hazards in Guadeloupe can be described by distinguishing between geological and meteorological hazards, if referring to the triggering forces. Most hazards are interrelated, one hazard being the triggering force for a “secondary” hazard (i.e., cascade events). Some hazards might have multiple possible drivers, for example landslides that can have both geological and meteorological triggering forces.

**Geological hazards**

The geology of Guadeloupe infers major risk linked to its active volcano of la Soufrière and seismic activity along the inner Caribbean arc. Tsunamis and landslides can be induced by those hazards. Recently, a tsunami occurred on the eastern coast of Basse-Terre (Deshais) triggered by an underwater landslide in Montserrat, itself induced by the volcanic activity of the Soufrière of Montserrat.

**Meteorological hazards**

The major meteorological hazard in Guadeloupe is cyclonic (hurricane) and tropical storm activity, having a direct impact through very high winds (up to 200 Km/h) and/or rainfall and secondary effects due to (i) sea water surges, waves and marine floods that can erode the coastal zone and (ii) heavy rainfall that can lead to inland floods and landslides. Figure 4 illustrates one of many landslides induced by the recent Rafael tropical storm (13-14/10/12), which was also the cause of many floods and one death.
Figure 4: Landslide on the N1 major road, following the October 2012 Rafael tropical storm (photo taken 24 hours after the event). The road has already been cleaned.

**Relationships between hazards**

Figure 5 (similarly to Fig. 2 for Naples) draws the different natural risks that need to be considered in Guadeloupe and the relationships between them, in terms of triggering forces and hazards. It is to be emphasised that landslides can have both meteorological and geological triggering forces (see also Annex II).

Figure 5: Relationships between the different hazards considered for the risk governance analysis in the Guadeloupe case study (arrows are orientated in the direction of triggering).
4. Decision making and risk governance in multi-hazard environments

4.1 Italy

4.1.1 General framework

Italy has a population of about 60 million people (59,464,644 ISTAT, 2011) and is divided into 20 administrative regions, 110 provinces and 8,104 municipalities (72% with a pop. ≤ 5000). Risk governance is grounded on the administrative structure of the country. As opposed to France, the Italian Regions have also legislative powers for natural risk management. Government services at different levels are structured to coordinate their operations and resources with non-governmental actors, through a mixed top-down, bottom-up organizational system that strategically integrates different capabilities (OECD 2009). To describe the general architecture of this system we distinguish between the following phases of the disaster mitigation and response chain/cycle:

Risk assessment and prevention

The Ministry of the Environment, Land and Sea Protection – (MATTM) determines trends and policies and coordinates the actions of the different authorities. The Presidency of the Council, acting under the coordination of the Environment Ministry and by agreement of other Ministries and Departments, sets out guidelines for land use planning for areas at risk. The National Department of Civil Protection is in charge of the preparation of guidelines for legislation related to risk prevention and it acts in cooperation with other Ministries for the distribution of funds for risk mitigation to regions and other local authorities (law 225/1992). This department (with its sub-branches at the regional, provincial and municipal levels) plays a relevant role in several phases of the disaster cycle. It is an umbrella institution and its main operational structures are the fire brigades, the military, the police forces, the forestry national service, the national technical services, some scientific research institutions and groups, the Italian Red Cross, the structures of the National Health Service, and the national Alpine rescue service. Even civil society fully participates, mainly through volunteer organizations.

Hazard, risk and vulnerability assessment activities are supported by a network of Competence Centres, i.e., institutions that provide scientific and technical expertise about the nature of hazards, vulnerability of populations and assets, and the development of technical measures to reduce them (OECD 2009): universities, national research centres and local authorities are part of this broad network. At the local level, regions, provinces and municipalities are responsible for the enforcement of land-use planning and building constraints related to risk assessment.

Early warning and forecast

The National Department of Civil Protection (DPC-under the Presidency of the Council of Ministers) coordinates actions of forecasting and early warning at the national level. The system has a distributed architecture, i.e., consisting of state and regional Functional Centres, interconnected to form a network for the exchange and processing of all information concerning real-time hydro-meteorological prediction and monitoring in support of the Civil Protection. The system which is still under development includes 21 Functional Centres, one per region or autonomous province, and a National Centre divided into three main branches: hydro geological risk, volcanic risk and forest fires. At present, 11 Functional Centres are at least partly operational. Functional centres work closely together with Competence Centres. The National Commission for the Prediction and Prevention of

---

1 In 2010 the voluntary system included 27 national organizations, 3,667 local volunteer organizations and 1,200,000 volunteers, which made almost 2% of the national population (Renzulli, 2010).
Great Risks and the **Public Weather Forecast and Meteorological Service** – managed by the National Air Force (NCPS) – give support to the Head of the Department of Civil Protection. The commission is organised into divisions and undertakes technical and scientific consulting with respect to forecasting and preventing various risk situations.

**Guidelines** are defined and indicated for setting-up warning systems for **hydrogeological risk**, but not volcanic and seismic risk. For volcanic risk, national emergency plans have been drawn up, which specify the characteristics of the monitoring system and procedures to be activated according to the alert level reached. With regard to seismic risk, alarm management systems are being developed for preventive seismic alert and immediate post-event alert called “Seismic Alert Management System” (SAMS) (Zollo et al. 2009).

**Emergency management and relief**

Emergency planning follows the so-called **Augustus method** elaborated in national guidelines. This method is an organic and systematic tool for producing civil protection plans in Italy, although it is not mandatory. The guidelines provide a blueprint for flexible planning and have been created to define, elaborate, manage, verify and update emergency plans. Each municipality must also establish a **Municipal Operations Centre** (MOC), in which managers of the various relevant authorities and municipal operational units are able to work together to define the intervention strategy, and an operations room organised by function.

The leading principle for warning and emergency management is **subsidiarity**. When municipal government capacities are insufficient to manage the scale of event, they are supported by provinces and regions as well as by the central government administration. Three different types of events foresee the involvement of different levels of government in emergency management:

- **Type A**: Events that can be managed by municipal authorities as part of their routine duties;
- **Type B**: Events of greater intensity that require coordinate intervention of more authorities at the provincial and regional levels as part of routine duties;
- **Type C**: Events of greater again intensity and extent that require coordination and intervention at the national level.

Table 1 summarises the operative organisation of the civil protection system depending on the type of event.

<table>
<thead>
<tr>
<th>Type of event</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>National</td>
<td>Operational committee</td>
</tr>
<tr>
<td></td>
<td>Major risk commission</td>
</tr>
<tr>
<td></td>
<td>National Operational room</td>
</tr>
<tr>
<td></td>
<td>Di. COMA. C (national coordination on site in case of major events)</td>
</tr>
<tr>
<td>Regional</td>
<td>Regional operational room</td>
</tr>
<tr>
<td></td>
<td>Crisis Unit</td>
</tr>
<tr>
<td>Provincial</td>
<td>Rescue coordination centre</td>
</tr>
<tr>
<td></td>
<td>Inter-municipal operational centres</td>
</tr>
<tr>
<td>Municipal</td>
<td>Municipal operational centre (COC)</td>
</tr>
<tr>
<td></td>
<td>Strategy area, decisional function;</td>
</tr>
<tr>
<td></td>
<td>Operative room</td>
</tr>
</tbody>
</table>

Table 1: Operative organization of the Italian civil protection system in case of emergencies

The activation of the various phases of the provincial and municipal emergency plans is the task of the President of the Regional Council or his/her delegates (prefects, mayors, etc.) pursuant to the relevant regional legislation. It also depends on the type of event (A, B or C).
If it is a type A event, once the mayor has received notice of a threshold being overcome from the authorities in charge (usually the Region or the Prefect), it is up to him or her to declare the corresponding alert level after an internal consultation with the responsible persons of the Municipal Civil Protection. If it is a type B or C event, it is the Prefect (in cooperation with the President of the Region, the mayors etc.) who is in charge of the coordination of the emergency activities (law 100/2012).

**Recovery and reconstruction**

The **Italian government** intervenes directly during emergencies by providing ex post financial aid and enacting ad hoc measures. Almost no private insurance scheme is available for covering natural disaster damage and so far State indemnification has been always guaranteed. Recently, there have been some legal proposals (law decree 59, 2012) for the introduction of an obligatory private insurance system for those living or having properties in high risk areas (Corriere della Sera 7/06/2012). In most cases, State indemnification of disaster losses follows a routine procedure. Whenever a natural catastrophe involves a given area, the Regional government proposes the declaration of a state of emergency for that particular area, which may involve the territory of a town, of a province or of an entire region according to the extent of the disaster (Monti and Chiaves, 2006). The Cabinet of Ministries must approve the proposal for the state of emergency to be officially declared. Approval opens the way to governmental interventions. Usually, the President of the Region establishes an *ad hoc* commission to undertake the evaluation of damages, and to fund and monitor reconstruction works. The Department of Civil Protection acts as an intermediary and technical expert body throughout the process and has a leading role in the reconstruction phase.

**Education and communication**

Each **Prefecture**, as a national authority, is in charge of providing information to the population. Locally, it is the municipality that has to communicate appropriate behaviours to be enacted in case of an emergency. Each municipality has to prepare an emergency plan including all the indications needed in case of an emergency (e.g., warning and evacuation procedures). The National Department of Civil Protection organises *simulation exercises* of national relevance, coordinates activities and programmes to foster the culture of civil protection, and provides activities of risk education that schools can include in their curricula. These activities are also undertaken by volunteers of the local units of Civil Protection. Some projects are also created and implemented together with environmental NGOs.

**Single risks characteristics**

The description provided above cross-cuts all of the hazards considered in this report, but there are specificities related to each one of them.

Here we report only some key information related to the management of single risks (for a more detailed description, see Annex I).

Systematic assessment of **landslide/flood hazard**, risk and vulnerability is performed by the River Basin Authorities, as stated by Article 12, Law 183/1989. At present, there are 40 river basin authorities on the national territory. Six of them operate at the national level, 13 at the interregional, 19 at the regional and 2 at the provincial levels.

The evaluation of flood and landslide risk is conducted at the level of each hydro-graphic district (see the EC Water Framework Directive 2000/60/EC). Special Plans (Piani Straordinari) include areas exposed to higher risks, and result from historical data, on-site evaluations and hazard/risk assessment. The River Basin Plans (PAI: Piani per l’Assetto Idrogeologico) comprise areas at a high risk according to return periods that are compatible with those indicated in the EC Flood Directive (2007/60/EC). For landslides, the term of reference is a national law 267/1998. These plans also contain indications concerning both structural and non-structural risk mitigation measures.
With regard to **earthquakes**, the focus of most of the legislation has been on improved building codes. According to the legislative Decree 112/98, Regions are in charge of the identification, classification and updating of seismic areas basing on general criteria decided by the State. The National Ordinance 3274/2003 ("First general criteria for the seismic classification of Italy and technical regulations for constructions in seismic zones") provided general criteria for seismic hazard mapping and a preliminary classification in four classes of national territory. After this ordinance, in July 2009, the new Italian Building code NTC08 came into force (Decreto 14/01/2008 Ministero delle Infrastrutture. Norme Tecniche per le Costruzioni, GU n. 29 del 04/02/2008). The code was mainly inspired by Eurocode 8, but it contains significant changes and improvements. First, the concept of "seismic zone" is discarded and, based on the seismic hazard map, the seismic action (elastic response spectrum) is defined for each point of a mesh (10X10 km) covering all of the national territory. Second, the Italian guidelines follow the so-called Performance Based Seismic Design (PBSD) requiring the definition of different levels of seismic actions and performance criteria to be met by structures under each level of loading. Moreover, after the L'Aquila event in 2009, the decree n. 39 of 28/4/09 transformed in the law n. 77 of 24/6/09 (Art. 11), allocated a budget of 963.504 M€ for the years 2011-2016 for activities dealing with seismic risk reduction in Italy and in particular: seismic microzoning studies, vulnerability reduction of strategic and private buildings and urgent intervention. Funds are distributed among different Italian regions on the basis of a seismic risk index linked to the probability of building collapse and derived from the seismic risk maps.

Emergency management is supported by three main surveillance seismic networks that rapidly improve the knowledge of a seismic event as soon as it occurs: the seismic network of INGV (National Institute of Geophysics and Volcanology), the National Accelerometric Network (RAN) and the Seismic Structure Observatory (OSS) of the civil protection department.

Activities to manage **volcanic risk** in Italy are conducted mostly at the national level by the Civil Protection Department, either directly or jointly with other agencies or Competence/Functional centres. There are not specific guidelines for warnings, but national emergency plans have been drawn up which describe the characteristics of the monitoring system and the procedures according to the level of alert. Risk prevention measures include the emergency plans drawn up on the basis of one or more eruptive scenarios and corresponding hazard maps. The plan includes emergency actions and evacuation instructions for the local population (Città della Scienza 2008).

From the institutional viewpoint, the Environment Ministry is responsible for the **forest fire** fighting sector. The assessment and planning in this area is based on guidelines issued by the Department of Civil Protection regarding forest fire emergencies and under the direct responsibility of the regions. Each Region has the competence to organise its fire fighting system, including prevention and planning activities. Regional plans for forecast, prevention and active struggle against forest fires have to work out risk assessment, considering both predisposing factors and causes. Mapping of the forests is planned on the regional level, but implementation is on the local level. Authorities at this level are obliged to assess the risk and have maps indicating the areas restricted for commercial or residential exploitation of land. Vegetation features, geomorphologic and meteorological conditions, human factors

---

2 Eurocode 8 (EC 8 – EN 1998-1, 2003) is the latest version of the European seismic code, issued in 2003, with the objective of achieving harmonization of earthquake safety throughout Europe. EC8 does not include any seismic hazard or classification maps and each country has to adapt the code through a National Application Document (NAD), including maps providing the basic hazard information (i.e. values of PGAS with a return period of 475 years).

3 The total amount of about 1 billion euros represents a very low percentage, probably less than 1%, of the budget required in Italy for the seismic retrofitting of all private and public buildings and strategic infrastructures. However, it is definitely a step forward in terms of increasing the knowledge of the importance of seismic prevention (Sabetta 2012).
(e.g., human behaviours), urbanization levels, road conditions and socio-economic features have to be taken into account. Fire fighting is carried out by ground teams in coordination with the National Forest Fires Air Fleet. The Unified Airborne Operations Centre (COAU) of the National Civil Protection is in charge of coordinating the National Air Fleet deployments upon request for assistance made by regional systems to DPC.

Finally, the risk of **major accidents in industrial plants** covers all potential causes of accidents (release of toxic substances, fire and explosion) related to the presence (i.e., use or storage) in the plant of considerable amounts of hazardous substances which may give rise to serious danger, whether immediate or deferred, to human health or to the environment, inside or outside the plant. The seriousness of this risk type is recognised by three European Directives (Directive 82/501/EC known as the Seveso Directive, Directive 96/82/EC known as the Seveso II Directive and Directive 2003/105/EC of 16-12-2003) and also required various legal provisions in Italy. According to the stipulations of the Legislative Decree 334/99 and the Ministerial Decree of 9 August 2000, proper risk assessment must include the identification of plausible accident scenarios and analysis of their consequences so as to define a suitable safety programme which envisages every possible action in order to identify problems before they arise. More precisely, the actions concerning how a industrial plant will respond to a major accident risk involves notification, by the managing director of a new factory, to the Minister for the Environment, the regional, provincial, municipal authorities, the prefect and the regional or interregional technical committee of the National Fire Brigade, with information concerning the managing director and the main characteristics of the activities being carried out in the factory; drawing up, by the managing director, a document defining management accident prevention policy, with an attached programme of action adopted to implement the safety management system (d.l 334/1999).

4.1.2 **Risk governance in Naples**

Table 2 outlines the main authorities in charge of the different phases of the disaster cycle in Naples for the different hazards under study.

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Risk assessment and prevention</th>
<th>Early warning and prediction</th>
<th>Emergency management and relief</th>
<th>Recovery and reconstruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flooding</td>
<td>River basin authorities, competence centers</td>
<td>National government, civil protection, fire brigades, forestal corp, regions, provinces, municipalities, armed and police forces, national health service, volunteers</td>
<td>Regional Government, Civil Protection</td>
<td></td>
</tr>
<tr>
<td>Floods (incl. debris flow)</td>
<td></td>
<td>Network of functional centers of civil protection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landslides</td>
<td>Civil protection, forestal corp, national aerial fire service, competence centers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire</td>
<td>Civil protection, competence centers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earthquake</td>
<td>Civil protection, competence centers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volcanism</td>
<td>National Civil Protection, competence centers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lava flow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pyroclastic flow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tephra fall</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lahars</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipeline break</td>
<td>Private companies</td>
<td>Private companies, functional centers civil protection</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Authorities in charge of the disaster cycle phases in Naples
As has emerged from the previous chapters, the institutional architecture for the risks under study is quite complex. As already described in chapter 1, in our view governance pertains to formal institutions empowered to enforce compliance, as well as informal arrangements that stakeholders either have agreed to or perceive to be in their interest (Renn 2008). It covers all phases of the disaster cycle from risk pre-assessment, characterisation/evaluation, appraisal, management and communication (IRGC 2008, IRGC 2009).

We can argue that good risk governance is concerned with a set of definable qualities which enable risks to be handled in society (Walker et al. 2010). In this way, it is used as something to be advocated, sought after and applied. The concept has therefore at least two different dimensions, one descriptive-analytical and the other normative-prescriptive. The challenge in our research has been to define key characteristics of risk governance in order to: i) describe different profiles across countries and natural hazard types; ii) compare them; and iii) identify the social and institutional barriers to effective multi-risk governance.

On the basis of the literature review and the first round of stakeholders’ interviews, we identified some relevant risk governance characteristics.

These characteristics cover the key matters of:

- decision support tools and plans
- governance level and scale
- stakeholder cooperation and communication

Before describing each item and how we operationalized it, we will briefly describe the general procedure we used for providing reliable evaluations. We provided a preliminary evaluation about the item on a Likert scale from 1 (min) to 7 (max).

Likert scales are commonly used in questionnaire surveys and are characterised by two main aspects: unidimensionality and reliability (De Vaus 2002; Denscombe 2007). A unidimensional scale is one in which each item measures the same underlying concept (e.g. hazard, exposure and vulnerability assessment as part of tools and plans available). A reliable scale is one on which individuals obtain much the same scale on two different occasions. To make our scales unidimensional and reliable we tested them with interviewees, changed some items, etc. Likert scales with ordinal data, as in our case, normally are five or seven points. We decided to use a seven point scale. The categories are ‘in order’. This means that the data in each category can be compared with the data in other categories as being higher or lower.

In a second phase, we asked local stakeholders’ feedback about our evaluations. This feedback round was performed with stakeholders with different expertise and responsibilities for risk management.

The evaluations were based on the knowledge, judgements and opinions of these stakeholders. We intended to treat these governance profiles as being dynamic rather than static tools that aim to help stakeholders to identify similarities and differences across countries and hazards as well as the institutional barriers to effective decision-making and governance. We stopped the interview round when the new interviewees were in agreement with the evaluations provided by the previous ones (for a description of the methodology see Annex I).

In the following we present our results.

**Decision support tools and plans**

During the desk study and the fieldwork, we collected a great deal of information regarding the tools, plans and measures available for risk management. Understanding what tools and plans are available and how comprehensive they are represents a pre-condition to allow their
effective integration into multiple hazard/risk assessment and management. We broadly classified them as follows:

- hazard, exposure and vulnerability assessment
- monitoring and warning system
- emergency plan
- risk mitigation measures

The results are shown in figure 6. We asked stakeholders to evaluate if these tools were available and their territory coverage on a 1 (min: tool/plan not available) to 7 (max: tool/plan available and covering the entire territory) Likert scale.

![Figure 6: Tools and plans available in Naples](image)

* Hydro-geological risk includes floods and landslides (managed by River Basin Authorities).
**Pipeline break risk has not been included due to the lack of data available

The picture emerging from the results reflects a (science-based) system with strengths and weaknesses.

The main strengths are the hazard assessment and the monitoring/warning system. This means that for earthquakes, volcanic eruptions, floods, landslides and fires, hazard maps are available and a monitoring/warning system is in place.

Exposure and vulnerability assessments are also available, but with differences depending on the hazards under study. For example, in the case of fire, the culture of vulnerability assessment does not exist. The same is partially true for hydrogeological risk. However, in
the case of volcanic and seismic risk, vulnerability maps are available for public buildings and private buildings are also well covered.

The main weaknesses are definitely related to emergency planning and risk mitigation measures. In the first case, many interviewees report that the preparation of an emergency plan by the municipal authorities is not compulsory and for this reason the plans are not available for all hazards. It is important to mention that 3 months after the interviews have been performed, a new law (law 100/2012) was enacted: emergency plans are now compulsory and all Italian municipalities had to finalise and approve them by 14 October 2012.

With regards to the availability of emergency plans in Naples, there are also differences among hazards. For volcanic risk, there is an emergency plan prepared and constantly updated by the National Civil Protection in Rome. In the case of hydrogeological risk, the responsible authorities are at the municipal level, although the emergency plan was still not available when this research work was performed. The same is true for seismic risk. In this case, as reported by several interviewees, the key problem is the identification of escape routes, especially in some areas of the city (e.g., Quartieri spagnoli). With regard to risk mitigation measures, a key problem is the lack of economic resources. Interviewees report that in the past more resources have been allocated for some risks, particularly for structural protection measures against flash floods and landslides. This may be due to the higher frequency of these events, and also to the fact that structural works protect entire communities, whereas in the case of seismic or volcanic risk mitigation, measures have to be adopted at the household level.

As we will better comment upon in the following (see chapter 6), some of the key barriers to effective multi-risk governance are derived or are strongly interlinked with the weaknesses described above.

**Governance level and scale**

To operationalize this characteristic, we used a set of qualitative indicators related to the national, regional/river basin or municipal role, as well as the public vs. private sector role (engineering consultants, industrial sector, and insurance).

Figure 7 synthesises the key results. For example, the management of volcanic risk is highly centralized, with the national civil protection authorities having a leading role and almost exclusive responsibility for it, together with the INGV (National Institute of Geophysics and Volcanology). For hydro-geological risks (floods and landslides), the structure is more decentralized, with the regional and the river basin authorities playing a key role. To be more precise, the river basin authorities are responsible for flood/landslide hazard and risk assessment and for the production of basin plans, hazard, and risk maps (usually at a scale 1:25,000). The regional authorities also take part in fire risk management, while the private sector role has a bigger role in seismic and hydro-geological risk management. This is due to insurance companies playing an increasing role in the management of these risks, with owners being responsible for the protection of their households and buildings. In the case of earthquakes, the emergency management is supported by two main surveillance seismic networks that rapidly spread information about a seismic event as soon as it occurs: i) the seismometric network of INGV (National Institute of Geophysics and Volcanology); ii) and the National Accelerometric Network (RAN) of the civil protection department.

As we will describe in more detail later in this report, these results show two strong barriers to multi-risk governance related to communication between agencies working at different levels (e.g., national vs. regional) and sectors (public vs. private).
Stakeholder cooperation and communication

The other risk governance characteristics that we took into account are related to stakeholder cooperation and communication. More precisely, we considered:

- Integration of hazard/risk assessment in planning: This characteristic relates to the integration of plans, maps and tools prepared by different authorities working at different levels in order to integrate the results of hazard/risk and vulnerability assessments into urban planning.

- Balance between governance tasks and available resources: This characteristic regards the relationship between the number of tasks that different formal and informal, public and private actors have to perform in order to govern the risk and the resources available to perform them.

- Culture of multi-stakeholder participation: This factor considers the involvement of local stakeholders in risk decision-making. For example stakeholder participation is a legislative requirement for the setting up of the river basin plans (landslides and floods) (2007/70/EC Flood Directive).

- Responsibility sharing between public actors and residents in risky areas: As the criteria, we used the issue of how much residents are responsible for the protection of their private properties (e.g. if it is formally binding by law or not).

- Risk communication: The criteria used are the public availability of hazard and risk assessment information.

Figure 8 summarises the results.
The picture emerging from these results shows again a system with strengths and weaknesses, but with numerous differences between hazards and risks. Considering the evaluations provided by our interviewees, the main weakness is the unbalance between governance tasks and resources. It is interesting to note that this unbalance is stronger for those risks (seismic and volcanic) characterised by a higher level of responsibility on those at risk for protection. Indeed, as mentioned already above, household mitigation measures are under the responsibility of homeowners for these two geological hazards. However, most of the time, resources are insufficient or household risk mitigation measures are too expensive.

The culture of multi-stakeholders’ participation seems to be very strong only for hydrogeological risks, possibly also due to the implementation of the EC Water and Flood Directive, which aims at reaching a wider stakeholder involvement in river basin management. For the other hazards, the decision making process is more top down. Hazard, exposure, and vulnerability assessment are publicly available and accessible online, even though there is no Web site including the information for all hazards in an integrated way. For example, hydro-geological assessments are available on the river basin authorities' Web sites [http://www.difesa.suolo.regione.campania.it/component/option,com_frontpage/Itemid,1/] , while the seismic maps are available on the National Institute of Geophysics and Vulcanology (INGV) Web site [http://terremoti.ingv.it/it/]. Yet, the question is: do the residents of Naples know that there are different authorities in charge of the assessments of different risks? Pipeline breakages are an exception, because this information is protected by privacy laws because pipelines are a potentially major terrorist hotspot.

Finally, these assessments are quite well integrated in existing urban planning, even if some interviewees maintain that there is a need to harmonize risk assessment for different risks in order to guarantee a better identification of priorities for risk prevention and mitigation. This is also clearly linked to the development of multi-hazard and risk-assessment methodologies

Figure 8: Risk governance characteristics in Naples
[Evaluation provided on 1-7 Likert scale: 1 minimum, 7 maximum]
that could help provide a better integration of the present decision support tools in existing urban plans (University Professor). As reported by urban city planners, there is still room for improvement in terms of mainstreaming and integrating risks into development policies, strategies and actions, and, more generally into urban environmental management and policies.

4.2 Guadeloupe

4.2.1 General framework

Risk prevention

At the national level, risk prevention and risk occurrence management is within the competencies of the Ministry of Interior, with a delegation at the departmental scale to the Prefect; the Ministry of Environment is in charge of developing knowledge on risks and developing prevention and mitigation tools and is represented in regions by the DREAL or (Direction Régionale de l'Environnement, de l'aménagement et du logement) or DEAL in Guadeloupe.

At the departmental level, the Prefect is, as said above, in charge of civil security and is therefore the coordinator of all aspects of risk management (either prevention or crisis management). Regional and Departmental Collectivities (which are overlapping entirely in Guadeloupe archipelago), as well as some inter-communalities collaborate to risk prevention, when assets in their responsibility (schools for example) are exposed to hazard and are part of their environment and land use competency. They are more specifically involved in the development of sustaining risk knowledge and awareness.

The mayor is in charge of civil security within the limit of his commune. This implies the availability of information about known potential risks, prevention measures and emergency actions in the case of risk occurrence. He refers in his actions to the Prefect, who may act as a subsidiary if the mayor is unable to fulfil his function. In the case of a hazard’s occurrence, he is kept informed by the Prefect, and organizes emergency actions in his territory.

Research on natural risk is promoted at different levels: at the national level, it is targeted towards answering and sustaining the needs in making policy and developing methodologies and guides (Ministry in charge of environment-MEDDE). At the local level, it aims answering specific problems, with funds from collectivities, state and/or Europe (e.g., CPER, FEDER; list of acronyms in Annex III).

Several public organisms are involved in research and helping with policy making, such as BRGM, INERIS, IRSTEA (ex CEMAGREF), IRSN, METEO France, CEA, CNRM, and CIREDA, as well as specific university laboratories such as IGBP, Clermont University, and UAJ, who specialize in different single hazards and risks. Public institutes also have state missions for specific risks. This has, however, a complementary and synergistic character and creates overlaps of responsibilities, which will be a subject of further discussion in this document (section 6).

Some public institutes, as we will discuss later, are in charge of monitoring hazards which can be forecasted. They also sustain the Prefect’s function to give alerts in the event of a hazard’s occurrence (MétéoFrance, IPGP-OVSG). They also act as experts (MétéoFrance, BRGM) after a hazard’s occurrence to confirm that observed damages have a natural triggering (constats de catastrophe naturelle).

Policy makers rely on the transfer of research to help produce policy documents that have priority over land planning documents and are used to inform at different levels and help decisions for prevention actions (DDRM, DCS, DICRIM). The departmental Prefect or a delegated state service coordinates development of these DDRM and DCS documents, while
the town’s mayor produces the DICRIM. These documents follow guidelines designed by the ministries for interior and for environment with the help of scientists and experts.

The **Departmental Dossier on Major Risks** DDRM (Dossier départemental des risques majeurs) compiles known risks within the department under the Prefect’s or delegate’s coordination, which are state services in the department (equipment, environment, health, security, communication) and the help of experts and scientists, which are public or private agencies whose knowledge or expertise may confirm the risk or crisis management policies (MétéoFrance, BRGM, ONF).

The DDRM covers, at the department scale, all risks (natural, technological, transport and conflict) classified as “major” in the studied territory (“major” implies high intensity and high exposure of human, economic or environmental assets). Some risks may be considered as having a negligible effect on those assets and might not be described in the document. Each single risk is described by its processes, typology and driving forces and a simplified hazard map is drawn. Existing policies for the risk are recalled, with advice on the behaviour of the population, before, during and after the hazard’s occurrence, are given. Agencies in charge of information are quoted. The DDRM presentation generally follows the highest to lowest intensity of hazards, however, no interaction is proposed in most departments. The DDRM is therefore more a compilation of known risk rather than a multi-hazard approach, either for prevention management or crisis response.

The **Synthetic Municipal Document** DCS (Documents Communaux Synthétiques) are the implementation of the DDRM to the municipality scale. Known risks are listed and described within the municipal territory, without considering interactions. This document is written by the Prefect security services and addresses the mayor who is in charge of informing the population of known risks. The mayor transfers this information to the population through the DICRIM (Document d’Information Communale sur les Risques Majeurs) providing information on known risks, existing or planned measures for prevention, protection and emergencies.

More specific planning documents have been developed in some departments to prepare vulnerable populations to specific crisis (such as family-PFMS- and school populations-PPMS- for the case of seismic risk in Guadeloupe).

Answering to the mayor’s demands, the Prefect prescribes the elaboration of **Risk Prevention Plans** (PPR) that are meant for single risks at the municipality scale and compiled into a “multi-risk” map. PPR are to be included in documents covering communal or multi-communal scales, such as SCOT (schéma de cohérence territoriale), PLU (plan local d’urbanisme) / POS (plan communal d’occupation des sols) and any municipal mapping. PPR usually leads to protection measures, recommendations and development constraints (e.g., no development, development under regulations, insurances limitations) in order to reduce the risk. Once elaborated by an association of expert scientists and policy makers, PPR are submitted to public inspection and finally approved by the Prefect and applied. PPR and DICRIM are freely accessible to citizens within the town hall, and are to be considered when the town delivers any authorization for public or private buildings. The Bachelot Law of 2003 also imposes on the seller in any dwelling transaction to provide information about the known exposure of the dwelling to any natural or technological risk.

**Crisis management. Feedback to risk prevention**

Unless the risk is at the national scale, emergency actions are under the Prefect’s and competent authorities’ responsibility, involving such actions as designated by the Prefect: alert the population, manage the administration of the crisis and ensure post crisis recovery measures.

In case of an emergency, the Prefect works with other services such as the regional directorate of the environment, spatial planning and housing (DEAL/DEAL), the regional
director of public finances, the prosecutor, NGOs and approved associations of civil safety (ADPC, Civil Protection, Red Cross, etc.) [see also “Acronyms” section].

The management of relief operations (DOS) is under the responsibility of the Prefect of the concerned department. The Prefect is advised by the commander of rescue operations (COS) who is a fire fighter officer (Fig. 9). For this mission, he is also assisted by the Departmental operational centre (COD) based in the Prefecture. Its composition is necessarily multi-service and is adapted to the nature of the event. If necessary, one or several Operational headquarters (PCO) are established close to the disaster and are under the direction of a sub-Prefect, although this is not always activated.

At the national scale, the Interministerial Operational Center for Crisis Management (COGIC) is responsible for preventing major risks and organizes relief in the event of a very serious disaster. The Operational Center (COZ) has the same functions as the COGIC, although at the “zone” level (supra-regional).

Figure 9: Organization of emergency response at different decisional levels

The Prefect (or the Prime minister, if the risk occurrence is at the national level) can decide on the application of an ORSEC (Organisation for Civil Security Response) plan. The ORSEC plan is a general plan describing the emergency organization in case of a disaster, when the local means are not sufficient to cope, and defines the actions needed to restore a normal situation.

The ORSEC plan in its latest version urges the municipalities to design (or delegate the designing to a technical consultant) a Safety Plan (Plan communal de Sauvegarde, PCS), in order to be prepared for a hazard’s occurrence, and have the means to act in an emergency (providing the necessary information to the citizens, evacuation, etc.). This PCS must consider all possible risks (natural, social or technologic) and should consider their possible concomitance. This last step would require going further than PPR with a multi-risk approach, where interactions and concomitance between risks is analysed.

The French system allows a risk transfer to insurers and the state: As soon as possible, after the hazard’s occurrence, damage observation statements (“CATNAT”) are made to validate the status of a “natural event” and support the settling of compensation by insurance companies. Compulsory insurance on property and dwelling occupation includes a contribution to a national funding envelop (“fond Barnier” created by law in 1995) for natural disaster (CATNAT = catastrophe naturelle), helping indemnities in case of unexpected and major events, but also sustaining risk research and prevention. This insurance coverage, however, leads to individuals and local decision makers to rely on it and to not take enough precautionary measures. To avoid decision makers relying on the “CATNAT” system,
compensation payments to private insurance policy holders are reduced in case of repeatedly occurring natural disasters, unless a risk mitigation policy (such as prevention plans) is launched by the local authorities.

4.2.2 Risk governance in Guadeloupe

Multi-hazard prevention plans have been elaborated and are applied in all Guadeloupean municipalities, and appended to urban documents. However, as stated by interviewees at different levels (municipalities, DEAL, SIDPC) this approach is more a compilation of single risks prevention plans. If the hazard is known to trigger a secondary hazard, it might be considered within the primary risk plan (e.g., cyclones and marine surges) or is just quoted in the PPR and dealt with at a separated level (e.g., earthquake, liquefaction, landslide).

As a French Department, the Guadeloupe archipelago has the same organization as any other. Research and policy supporting actions are strongly dependent upon the volcanic and seismic observatory (IPGP/OVSG), local universities and the different public agencies having a local representation (BRGM, MétéoFrance).
<table>
<thead>
<tr>
<th>Driver</th>
<th>Hazard</th>
<th>Hazard assessment</th>
<th>Prevention/ preparedness</th>
<th>Monitoring</th>
<th>Advise on Alert</th>
<th>Alert</th>
<th>Crisis management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyclone, tropical storm</td>
<td>Cyclone, tropical storm</td>
<td>MétéoFrance</td>
<td></td>
<td></td>
<td>MeteoFrance</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wind</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Heavy Rainfall</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy rainfall</td>
<td>Inland flood</td>
<td>DEAL/BRGM, private</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storm surge</td>
<td>Marine inundation</td>
<td>MétéoFrance/ BRGM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Erosion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waves</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Volcano</td>
<td>OVSG/Univ/ BRGM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ground movement</td>
<td>BRGM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Volcanism, earthquake,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>landslide</td>
<td>OVSG/Univ/ BRGM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Earthquake</td>
<td>OVSG/Univ/ BRGM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Authorities in charge of the different disaster cycle phases in Guadeloupe
Figure 10, extracted from the DDRM (2004) of Guadeloupe shows the top-down organization of emergency response, around a fixed cell of commandment (Poste de commandement fixe-PCF), as designed for a cyclonic event where MeteoFrance is in charge of reporting the alert level to the Prefect, who decides whether to declare this level to the population through each municipality mayor, and with the collaboration of the media. In case of an earthquake, a volcanic eruption and/or a tsunami, the OVSG is in charge of communicating the alert level to the Prefect.

This organization follows the general rules of emergency response as described above for crisis management in France. In addition, different emergency plans are ready for Guadeloupe: ORSEC departemental plan, and its communal declination, PCS, (currently ready for 12 of 32 municipalities), emergency plans in case of human victims, a specific plan for the industrial zone of Jarry, and economic defence plans. Specific safety and rescue plans are ready in case of the occurrence of cyclones (Plan ORSEC Cyclones 2004), earthquakes (Plan de secours spécialisé Seismes 1998) and volcanic eruption (Plan de Secours spécialisé Volcan 1999).

The interviews underlined that most stakeholders are confident in the top down organization, where the department prefect is the focus point for all decision making. They are also attached to their own function in this organization. It is to be underlined that the top-down organization of French administration is however decentralized: the state local representatives (the Prefect and his service) at the head of this top-down pyramid are deeply involved in the departmental dynamics, and very aware of local challenges.

This organization of risk management also guarantees that all major risks are quoted in the different documents from DDRM to multi-risk PPRN, which is a preparation for a multi-hazard approach. Nevertheless, as confirmed by the interviewees, this approach is still a compilation.
of single hazards, and would need a better integrative approach, by using GIS mapping tools and developing links between primary and secondary hazards. In the following figures, a risk governance analysis for Guadeloupe is presented using the same characteristics already described for the Naples case study (see section 4.1.2 for a description of the characteristics employed and the evaluation tools).

**Decision support tools and plans**

With regards to the decision support tools and plans (Fig. 11), hazard and exposure assessment as well as the warning system and emergency plans are strengths of the system when high intensity hazards such as cyclones, earthquakes and volcanic eruptions are considered. In general, Guadeloupe is well ahead in terms of major hazards knowledge and management (earthquakes, volcanism, cyclones), and it is less ahead for “secondary” hazards (inland floods, tsunami, erosion). Vulnerability assessments, as described by interviewees, are giving priority to population security. However, the lack of knowledge of the other dimensions of vulnerability lead to insufficient mitigation measures. Considering all risks, there is also a need to improve knowledge about the vulnerability of the territory and to further develop risk mitigation measures.

![Figure 11: Tools and plans available in Guadeloupe](image)

***Governance level and scale***

Figure 12 shows that the prefect, with the help of the state representative for the environment (DEAL) and the mayor are the main actors in risk management, whereas territorial collectivities are little implied. Such a distribution might be different in another department, depending upon the hazards and exposures. Private sector actors were not interviewed in Guadeloupe: their actions in risk management refer to the law: industrials have to guarantee their own security, insurers refer to the catnat system. Private engineering consultants might take part in risk assessment or in the elaboration of the relevant documents, but they are therefore under contract to public services.
Figure 12: Role of the public (municipal, regional and national) and private sectors in Guadeloupe
[Evaluation provided on a 1-7 Likert scale: 1 minimum role, 7 maximum role]

**Stakeholder cooperation and communication**

Figure 13 underlines the results of the risk governance characteristics. Hazard, exposure and vulnerability assessments are available to the public, but very little consulted. Specific campaigns for education on seismic risk have recently been done, in the frame of a nationally promoted “plan seisme”. Little has been made on other risks.

Decision support tools are well integrated in urban planning through PPR plans (see section 4.2.1). With regard to the balance between governance tasks and available resources, the “Catnat” insurance system covers natural disasters but is likely to lead to a transfer of responsibility from individuals to decision makers. However, it is also important to bear in mind the specificity of Guadeloupe, as one of the French territories with less insurance penetration than the rest of France.

Finally, the culture of multi-stakeholder participation is in general quite weak in Guadeloupe, aiming at a wider stakeholder involvement in local developments of land use planning in order to mitigate the risk (PAPI). The results again point to the dichotomy between high intensity/low frequency vs. low intensity/high frequency risk: the profile underlines once again the lack of stakeholder participation for low intensity/ high frequency hazards such as continental floods, erosion and tsunami.
5. Barriers and benefits to effective decision making in the case of multiple hazards

5.1 Barriers

Two key barriers for effective decision making in the case of multiple hazards are common in our case studies:

Different historical evolution of science and innovation in geological vs. meteorological hazards

Because of different professional development paths, the process of decision making—and even the language used—for geological hazards has evolved differently from meteorological or technological hazards (see also Romieu et al. 2010).

For effective multi-hazard and risk management, it seems that a priority needs to be given to bridging the long-lasting gap between the various hazard disciplines, partially due to different evolution, innovations and discoveries in the associated scientific disciplines. Different methodologies and levels of uncertainty in hazard/risk assessment make comparisons and integration, as well as dialogue, between different practitioners particularly difficult.

One of the examples, often reported by the Italian interviewees, concerns the monitoring and warning system. Monitoring, forecasting and hazard/risk assessment for hydro-geological risks is characterized by lower levels of uncertainty in comparison to earthquakes. Also inherent to each phenomenon are different temporal/spatial scales, where the methodological approaches for hazard and risk assessment are very different. For example, seismic vulnerability assessment is based on maps and on the physical vulnerability of individual households’, while the hydro-geological risk assessment is grounded on the spatialisation of hazard and risk maps (often at a scale of the order of 1:25,000) as well as event modelling and simulations.
The Guadeloupian study underlined a higher level of knowledge and investment in major hazards/risk (earthquakes, volcanism, cyclones) with regards to secondary hazards such as floods and landslides, due to a culture of focusing on high intensity/low frequency events at the expense of low intensity/ high frequency events.

The deep differences in the approaches, tools and methodologies used for single risk management constitute a barrier to integration also because they resulted in different practices for risk management.

**Lack of population awareness on risks, multi risks and cascade effects**

The lack of the population's awareness of risks, and *a fortiori* of multi risk and cascade effects, is a common problem in Italy and Guadeloupe. In the second case, the desk study underlined different degrees of risks awareness, depending on the risks, that can be explained by intensity and recurrence of events and consequences on human assets. If the culture of cyclonic, earthquake and volcanic primary risks is well anchored in Guadeloupe at all levels of decision and individuals, it is less developed for secondary risks such as tsunamis, landslides, marine and inland floods, and coastal and slope erosion. Such a hierarchy will be different in other territories where the high-intensity and high frequency of individual hazards will result in another hierarchy in risk awareness.

The inquiry showed that Guadeloupian risk stakeholders have a strong culture of risks due to multiple major risks on their territory. It is likely that French metropolitan stakeholders might be less aware of risks. The consciousness of individual citizens to risks, however, appears insufficient (Léone, 2008), leading to the dramatic lethal consequences of “small” events (flash floods in Les Abymes, 2011, flash flood in St Claude, 15/10/12). This lack of awareness may be due to a lack of efficient communication, but it is also encouraged by the insurance coverage of natural disasters (Catnat) that leads to a relative low concern by individuals.

Beside the two mentioned above, most of the barriers identified by stakeholders are specific for each case study. In the following, we will present a synthesis of the the results (for a more detailed description check Annex I and Annex II).

For Naples:

**Lack of an emergency plan including information about multiple hazards and risks**

At present in Naples, there is no municipal emergency plan that takes into account multiple hazards/risks nor cascade effects. There are several different plans that include a description of evacuation routes, collection points etc. for single hazards (and not even for all of them). Multi-hazards or risks are not included and there is not an integrated and comprehensive emergency plan. To justify this *status quo*, our interviewees provide different explanations.

First of all, the emergency plan is not a legislative obligation for local/municipal authorities. It is recommended. This, together with the lack of resources, discourages several mayors (i.e., the authorities responsible for the emergency plan) to prepare them. Still, many municipalities in Italy do not have an emergency plan and this is mostly due to the lack of human and/or economic resources, lack of political will, and logistic difficulties (Civil protection officer). It is important to mention here that 3 months after the interviews were performed, a new law (law 100/2012) was enacted where emergency plans became compulsory and all Italian municipalities had to finalise and approve them by 14 October 2012.

Interviewees from the fire brigades and civil protection sector report that mayors are often unprepared to make emergency decisions, even if by law they have to, and tend to rely more and more on specialized corps for their decisions. Another explanation for the lack of an integrated emergency plan regards the fact that plans for different risks are under the responsibility of different authorities. For example, the plan for volcanic emergency management has been prepared by the National Civil Protection, while hydro-geological
emergency plans are under the responsibility of municipal authorities. The emergency plan for hydro-geological risk is still not available (in the year 2011).

**Lack of interagency cooperation and communication and of public/private partnership**

Interagency cooperation and communication may be particularly difficult for risks that are managed by authorities acting at different levels. In general terms, interviewees tend to agree that a decentralized system is more conducive to effective risk governance. In the case of hydro-geological risks, the risk assessment system is highly decentralized and the river basin authorities play a key role in liaising between national and municipal agencies.

However, decentralization has also some limitations related primarily to the lack of capacity at the local level, funds dedicated to disaster risk reduction often being channelled elsewhere, and the fact that it does not automatically lead to more inclusive decision making processes.

The difficulty in communication among public agencies, working at different levels, is amplified in the cases of agencies working at different scales, and especially for public and private actors. Indeed, industrial and technological risk management is mostly under the responsibilities of private industries and their assessment is often not appropriately integrated into the planning handled by public authorities.

**Complex exchange function between regulation and governance practices**

The historical evolution of science and innovation within different hazard contexts implies also the adoption of different practices and regulatory frameworks. As mentioned above, seismic risk assessment is based on maps and considers the vulnerability assessment of individual buildings, while the hydro-geological risk assessment is grounded on maps, events modelling and simulations. One example is related to the different levels of responsibility attributed to private actors in geological versus meteorological risk prevention. In the case of geological risks, the level of private individual responsibility is much higher than for meteorological risks, where the risk prevention is mostly under state/national responsibility. Multi-stakeholder participation in decision making also takes on different shapes depending on the hazard under study. The harmonisation of these practices is one of the key barriers to multi-risk governance.

**Lack of capacity at the local level**

A multi-hazard approach is mostly needed at the local (e.g., municipal) level and, for this to happen, local decision making has to be empowered, not only in terms of political, but also financial capacities. Especially the latter represents a key vulnerability in the present risk management system.

**Research-practice divide**

Some interviewees are sceptical about the possibilities of success for a multi-hazard and risk approach. As an example, they report on the unsuccessful integration between landslide and flood hazard/risk maps in the existing river basin plans. Other interviewees mention as a key problematic issue the research/practice divide and more precisely the fact that research results are not always implemented by practitioners in their everyday duties. “In Italy there is a gap between the vast scientific knowledge available and its implementation. The main objective of scientists and researchers is to publish new research results. The main objective of practitioners is to fulfil legal requirements using effective and simple methodologies and avoid liability in case of damages or, even worst, human life losses. It is clear that these objectives are divergent and not always easy to reconcile “ (Regional Civil Protection officer).

For **Guadeloupe**:

**Hierarchy in considering hazards and risks**
The above described hazards can often be considered as multi-hazards as they can trigger other natural hazards. From this consideration, some hazards can be considered as major and primary, with induced effects being secondary. Such a hierarchy refers, however, more to the process than the intensity (e.g., a secondary hazard such as a tsunami could be a much more damaging event).

From the interviews, present-day governance also considers this hierarchy. It results from a classification of high intensity/low frequency events (earthquakes, volcanism,) with regards to high frequency/low impact events (inland inundation and ground movement). Tsunami and coastal risks were quoted, but did not appear as major risks to interviewed stakeholders.

This hierarchy lead to insufficient knowledge for some single risks. This mostly concerns secondary hazards and refers to knowledge (inundations, secondary effects of cyclones) and management (inundation, smaller tropical stormy events, coastal risks etc.), the result being an impediment to sound multi-risk approaches of those risks.

The inquiry also pointed out the different points of view of the stakeholders, regarding the incomplete knowledge on risk assessment, prevention capacity, exposed assets vulnerability and forecasting capacity.

**Insufficient supra-regional risk governance**

The French organization refers to a departmental administrative level (with local state representation and collectivities). Some hazards, though, need a more regional approach, if not supra regional, on top of the national or departmental coordination (seismicity, volcanism, cyclones).

It is already the case for cyclonic alerts, where MétéoFrance is associated with organisations from the US and Central and South America. The long lasting volcanic event in Montserrat (ash clouds in 2000, secondary tsunami along the Western Guadeloupe coast) underlined for the interviewed stakeholders that better regional knowledge and management would have facilitate the management of secondary hazards, such as the ash cloud impact on Point à Pitre or the tsunami on Deshaies.

A supra regional insight in risk would allow knowledge and risk assessment sharing, as well as helping in crisis management and feedback from existing events.

**Conflict between a culture of safety and development at the municipal level**

One point of conflict that may appear at the municipal level is not due to risk governance, but to the fact that the responsibility of the mayor is engaged for the security of citizen, whereas he is also in charge of developing his town. ie the mayor and his technical services local authorities need to evaluate the relative importance of individual freedom and private property rights to allow urban and economic development versus publicsafety.

**Partial understanding of vulnerability and prevention**

It also appears to most of the interviewees in Guadeloupe that vulnerability is mostly understood as population vulnerability during the events, and is considered to be sufficiently known. Possible damage on the economy and environment was little quoted, and apparently little assessed. However, major events such as 1976 eruption at la Soufrière, or more recently the impact of the eruption of the Soufrière of Monserrat, are known to have largely affected the economy of the archipelago.

An investment in risk communication and education strategies seems necessary, especially to increase residents’ risk awareness and preparedness. Mitigation or adaptation works were only quoted, when the question was asked to the interviewees, as involving the adaption of dwellings by individuals, or coastal defences.

This confirms that the priority of stakeholders in Guadeloupe is the safety of the population, likely due to a high vulnerability of the population to several major risks. It must not, however, prevent them from considering other aspects of vulnerability (economy, environment etc.)
and prevention (works) that can impact upon the risk management over the longer term, and in its territorial dynamics.

5.2 Benefits

Stakeholders in both case studies maintain that a multi-risk approach would sustain a good coordination of major risk management. A multi-risk approach is considered to be particularly useful to gain a holistic view of the risks on the territory, to improve emergency management, and to make decisions about prevention/protection measures more coherent.

In Guadeloupe, the quantified comparison of risks that would allow a multi-risk approach did not appear as the main benefit to stakeholders (when compared to above-mentioned benefits). Some cascade effects are already considered in a multi-risk approach, such as the side effect of liquefaction, triggered by earthquakes, taken in account in microzoning of municipal territories. Safety plans (PCS) in progress in municipalities or enterprises to organize the crisis management, are asked to be developed by considering all possible hazards, whether natural, social or technological. Some risks are tightly linked, such as frequent inland inundation and ground movements, and several interviewees think that a common assessment of those risks would improve their management capacity.

In Italy the risk comparison allowed by a multi-risk approach is definitely considered an added value, which helps with the identification of priorities for actions. Indeed, up to now, the decision-makers base their priorities on the risks that could be most reduced, and not necessarily on the highest risks. Stakeholders point out that a multi-hazard/risk approach would be very useful and should be implemented at the level of the regional functional centre in charge of the warning, i.e., a centre providing on-time warning information for a multi-risk situation.

Some cascade effects are already considered and monitored within a multi-risk approach such the period after a wild fire being more susceptible to landslides. (More precisely there is a webcam system in place on the most instable areas of the Vesuvio slopes).

In both cases, several interviewees underlined that a multi-risk approach cannot be subsidiary to a single risk approach: both approaches have to be pursued. This comment reinforces the result of the desk studies which pointed that the knowledge of many risks still has to be improved, or dealt with, individually, in terms of risk assessment and monitoring at least.

On the contrary, for prevention, crisis management and recovery, a multi-risk approach would be highly beneficial, avoiding conflicting measures, and saving investment in terms of cost/efficiency.

In terms of future developments towards a multi-risk management, territorial databases collecting information about multi-hazards are needed in both case studies. These databases should include demographic data, economic data on public and private dwellings, data on road- and other lifelines, agriculture, as well as the environmental value of ecosystems and natural spaces. This would help with the assessments of potential or effective damages in relation to single or multiple hazards, in a more integrated way.

In Guadeloupe there is a need for an exhaustive territorial diagnosis to help assess the vulnerability of assets to the different risks. Such a diagnosis should provide a typology of the different components of the territory exposed to risk.

Guadeloupean interviewees believe that the existing organization is to be the basis for setting up a multi-risk platform, under the coordination of the Prefect within its functions. Such a transversal platform would help a more efficient exchange of information about the territory and a relevant documentation on risk management, via GIS and other NTIC.
Above the existing departmental organization, there is a need, underlined by stakeholders, to up-scale this multi-risk approach to a supra-regional dimension in terms of knowledge, risk and disaster management. The interviewees also stated that much more cooperation is necessary between neighboring islands (whether independent, - Montserrat or Dominica, or French overseas departments— Martinique). This cooperation should be built in terms of observatory network, alert, common GIS platform, etc.

In Italy, stakeholders point out the need to build a database that includes different research results in order to make them more transparent and easily accessible for the general public. One stakeholder identified three possible steps to move towards a multi-hazard risk assessment: i) Better sharing of multi-risk assessments information among the competent authorities; ii) A stronger coherence to deal with hydro-geological, volcanic and seismic risks, which are strongly inter-dependent, by a coordinating agency; iii) A single coordinating agency dealing with natural and technological risks.
6. **Key findings**

As remarked at the beginning, this deliverable provides:

- A background to understanding what multi-hazard and risk assessment is about (in comparison with single risk assessment), how it can be applied, what are its potential benefits, and what are the limits in terms of decision making.
- An overview of multi-hazard and multi-risk environments in the two selected case studies of Naples and Guadeloupe.
- An overview of the institutional/governance frameworks at the national and local scales.
- An assessment of the current situation by profiling the key characteristics of risk governance in diverse natural hazards contexts in different case studies.
- A summary of the benefits and barriers to effective multi hazard and risk governance as described by the stakeholders involved in the research.

Initial evidence in relation to these issues came from the desk study. Results allowed to identify the key similarities and differences in the governance systems in Italy and France. For example the legislative power at regional level, the role of the civil protection service and the networks of competence and functional centers are Italian specificities. In the French West Indies there is instead an insurance system and an integrated approach to risk assessment (PPR plans). The warning systems and emergency management are not extremely different, with the exception of the key role played by the prefects in Guadeloupe. While the public availability of hazard and risk assessment is rated very high in Napoli, in Guadeloupe this is the case for planning integration at different levels (probably again due to the key connecting role of the PPRs plans).

Differences across natural risks are also striking, with a weakness emerging in interagency communication and cooperation especially if risks are managed at different levels as in Naples (e.g. volcanic and hydrogeological risk). Science based decision support tools, especially for hazard and risk assessment as well as the monitoring and warning system have been evaluated as well advanced in both case studies. Monitoring, forecasting and hazard/risk assessment for hydro geological risks is characterized by lower levels of uncertainty in comparison with the seismic one. More efforts are needed instead to implement vulnerability assessment, especially in Guadeloupe, and integrated emergency planning, especially in Napoli. There the investment of more resources at the local level seems a priority, so that knowledge available at, for instance, national and regional levels can be profitably used and disseminated locally.

**Novel insights** also emerged during discussions with local stakeholders, the focus groups with experts and the comparison of country reports. The following figure (Fig. 14) and table (Tab. 4) summarise the key results about: i) risk governance profiles; ii) benefits and barriers to effective decision making for multiple hazards.
Italy (Naples)

Tools and plans availability

Availability of hazard and exposure assessments; very good monitoring and warning system; lack of resources for risk mitigation

Risk governance levels

Centralised vs. decentralised systems, depending on the type of hazard. Stronger private sector role for industrial risks

France (Guadeloupe)

Tools and plans availability

Availability of hazard and exposure assessments; good organisation of alert and emergency; lack of knowledge on vulnerability

Risk governance levels

Binar organisation between State (department prefect) and municipalities (mayor)
Good level of public availability of risk assessment and its integration into urban planning. Strong unbalance between governance tasks and resources. Different levels of stakeholders’ participation and individual responsibility depending on the hazard.

Good involvement of stakeholders and balance between task and resources; little interest of individuals despite public availability of documents. Insufficient communication to public (except earthquakes).

Figure 14: Comparison of risk governance profiles in Italy and Guadeloupe
<table>
<thead>
<tr>
<th>Benefits</th>
<th>Naples</th>
<th>Guadeloupe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global /holistic view</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Integration of natural and technological risks</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Development of global platforms (GIS, documents, education)</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Development of a transversal exchange system</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>Development of a multi-risk functional centre for warning</td>
<td>✔</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Barriers</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Different historical evolution of science and innovation in geological vs. meteorological hazards ➔ different methodologies and levels of uncertainty</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Lack of public awareness on multi risks and cascade effects</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Lack of emergency plan including information on multiple hazards and cascade effects</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Lack of interagency communication for risks that are managed by authorities acting at different levels</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Lack of public/private partnership, especially for industrial/technological risk management</td>
<td>✔</td>
<td>n.a.</td>
</tr>
<tr>
<td>Different governance practices, distribution of responsibility, culture of multi-stakeholders participation</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Lack of financial capacity at the local level</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Research vs. practice divide</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Supra-regional risk governance</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Understanding of vulnerability and prevention</td>
<td></td>
<td>✔</td>
</tr>
</tbody>
</table>

Table 4: Synthesis of the key benefits of and barriers to multi-hazard and risk assessment as perceived by local stakeholders in Naples and Guadeloupe (✔=yes; n.a.=not available)

The results presented in this deliverable will be further discussed, developed and tested during task 6.4 “Synthesis: benefits and barriers to a multi-hazard approach”.
Annex I: Italy and Naples

1. Risks under study

In the period 1998-2009, Italy was mourning more than 20,000 fatalities due to natural catastrophes (EEA 2011). In terms of fatalities, all over Europe the country is second only to France. In the last two decades (1990-2010) the overall costs for natural disasters have been estimated to approximately 100 Euros billion (Monti and Chiaves 2006). Every year the Government spends on average 3.5-4 billion Euros to indemnify damages caused by catastrophic events (EEA 2004).

These figures immediately show how natural disasters represent a dramatic problem for the country. Moreover the Italian territory is vulnerable to almost all natural hazards, even if in this report we will focus only on some of them, i.e. hydro geological hazard, earthquakes, forest fires and volcanic eruptions.

**Hydro geological** hazards (floods and landslides) represent the most frequently occurring natural hazard in Italy. Over the last 80 years, there have been as many as 5,400 floods and 11,000 landslides and avalanches. About 5 million inhabitants are at very high landslide and/or flood risk. More than 10,000 people have died from hydro-geological related causes in the last century and more than 350,000 remained homeless or had to be displaced (Sabetta 2012).

The last landslide Census (Trigila and Iadanza 2007) identified 482,272 areas at “very high” landslide risk on the national territory, which cover a surface of about 20.5 km² (6.8% of the Italian territory). The picture about landslide risk becomes more worrying if we consider the population exposure: 992,403 persons are at very high risk, that is, 1.74% of the Italian population (56,995,744 inhabitants, 2001 ISTAT Census) (ISPRA 2008). Italy has the highest cumulative number of deaths or missing people and the highest expected yearly loss of life in Europe, and, after Japan, the second highest landslide risk of the industrialised countries (ibidem).

---

**Fig. 1.1** - Location of 2533 sites affected by landslide events with direct consequences to the population. Period 650-2008 (Source: CNR-IRPI)

**Fig. 1.2** - Location of 1836 sites affected by floods events with direct consequences to the population. Period 590-2008 (Source: CNR-IRPI)
Regarding **earthquakes**, up to 38% of the Italian population (i.e. about 23 million people) lives in highly seismic areas (zone 1 and 2) where 60% of the buildings are not constructed according to anti-seismic rules (Sabetta 2012).

Since 1000 A.D. nearly 30,000 events occurred. In the last two centuries earthquakes caused about 160,000 victims; moreover, they damaged and/or destroyed a great part of our historical and artistic heritage, whose value is not quantifiable.

There are several **active volcanoes** on the national territory (see Fig. 1.5) including Etna, Stromboli and Vesuvio. Almost 2 million people all over the country are exposed to volcanic hazard: Etna 1 million people, Vesuvio 600,000 people, Campi Flegrei 250,000 people, Vulcano 15,000 people (in summer).

Fig 1.5 - Active volcanoes in Italy (Source: INGV-National Institute of Geophysics and Volcanology 2012)
The forests cover 10 million hectares or one third of Italy; 60% of the forests are privately owned and 40% are public property. As much as 10% of the forests are national parks. Every year thousand hectares of the national territory burn for several causes, related also to anthropic factors. In the last 30 years 12% of the national forest has been destroyed because of fires (DPC 2011).

Forest fires are extremely frequent events, naturally in the hot and dry periods of the year, but also in the winter. The average of burned surface from 1990 to 2011 is 78,215 hectare/year.

Fig. 1.6 - Total burned surface from 1990 to 2011 (Sabetta 2012)

Quite often a number of severe forest fires occur simultaneously, thus high capacity for communication, prioritization and coordination is necessary. Fires are often started by arsonists hoping to claim to the degraded land for new construction. In the year 2010, 88% of the forest fires have been man caused (both voluntary and involuntary; 11% unknown and 1% natural). Large forest fires need water bombing from the air to be extinguished. The number of requests for water bombing generally reaches around 1000 per year but have in some years reached 2000 or more (OECD 2009, DPC 2011).

Besides the risks related to natural hazards, some areas of the Italian territory are also prone to the risk of industrial accidents.

Industrial accidents are defined by European legislation, in particular by the Seveso II Directive 96/82/EC as amended by 2003/105/EC on the prevention and mitigation of major industrial accidents. The directive covers stationary establishments that store or process certain dangerous substances above a defined quantity threshold (EEA, 2011).

In Italy 1109 sites fall under the requirements of this legislation (Fig X). Transport and all transport-related accidents are excluded from this legislation if they are not directly related to the scope of the directive.4

Figures are reportable major accidents: a) any fire, explosion or accidental discharge of a dangerous substance involving, a quantity of at least 5% of the quantity established in the annex of the Directive, b) an accident involving a hazardous substance and producing one death, six persons injured inside the establishment or one outside the establishment, c) damaged and unusable dwellings outside the establishment, d) evacuation of at least 500 persons, e) interruption of vital infrastructure for at least 1,000 persons, f) permanent or long-term environmental damage to 0.5 ha protected habitat, 10 ha of other land, 10 km river, 1 ha lake, 2 ha delta or coastline or 1 ha of groundwater aquifer, g) property damage of at least EUR 2 million inside or EUR 0.5 million outside the establishment, h) any accident triggered by an activity falling under the Directive with transboundary effects.

---

4 Criteria for a reportable major accident: a) any fire, explosion or accidental discharge of a dangerous substance involving, a quantity of at least 5% of the quantity established in the annex of the Directive, b) an accident involving a hazardous substance and producing one death, six persons injured inside the establishment or one outside the establishment, c) damaged and unusable dwellings outside the establishment, d) evacuation of at least 500 persons, e) interruption of vital infrastructure for at least 1,000 persons, f) permanent or long-term environmental damage to 0.5 ha protected habitat, 10 ha of other land, 10 km river, 1 ha lake, 2 ha delta or coastline or 1 ha of groundwater aquifer, g) property damage of at least EUR 2 million inside or EUR 0.5 million outside the establishment, h) any accident triggered by an activity falling under the Directive with transboundary effects.
In recent years, some accidents categorised as transport accidents (and thus not included in the scope of the Seveso Directive) involved hazardous substances that are regulated by the directive. An example is the accident occurred in June 2009 in Viareggio (Italy): a derailment of a freight train and the explosion of two tankers with LPG causing 32 fatalities and the evacuation of 1 000 people (Brambilla and Manca, 2010).

Another issue not covered by the Seveso Directive that poses a major industrial-related risk concerns pipelines outside establishments (e.g. pipelines for oil or natural gas transport). Damages to pipelines can be not only human-induced, but also NATECH accidents, i.e. industrial accidents triggered by natural hazards, such as earthquakes, landslides or forest fires. Even if serious NATECH accidents on pipelines are not reported for the Italian country, observations on damages on gas pipelines caused by the L'Aquila earthquake revealed that natural hazards could trigger serious accidents also in Italy (Grimaz & Maiolo, 2011).

The city of Naples is exposed to all the above listed natural hazards. First of all, earthquakes by both the Apennine chain tectonic seismic source and the Campi Flegrei and Somma Vesuvio volcanic sources can be felt in Naples. Moreover, landslide phenomena can involve both the welded volcanic rock steep slopes of the hills bordering the city and the looser pyroclastic covers (compacted ash) emplaced by more recent volcanic activity. The Neapolitan Yellow Tuff, a soft welded pyroclastic rock which makes up most of the Naples underground, in the past was intensively exploited by man and now is crossed by a net of subterraneous galleries whose roofs often collapse. Flood events are very frequent as well, due to the geomorphology of the city, which mainly lies on narrow coastal plains bordered by pyroclastic hills, whose slopes quicken the flow of sediment-laden waters toward the sea. (Alberico et al., 2011). In the last years severe forest fires have been reported in the city of Naples, mainly during the summer period: more than 40 forest fires were registered in 2011 (Department of Agricultural, Campania Region, 2012). Most part of these fires were man caused and affected the green areas of the city of Naples. Several industrial plants are concentrated in the Eastern area of the city of Naples and a natural gas network crosses the whole city. Because of a relevant exposure to several natural hazards, the occurrence probability of a NATECH event in the city of Naples cannot be neglected.
The figure here below represents how the hazards considered for the Naples case study are interrelated and what are the possible cascade effects in a multi hazard perspective.

Fig. 1.8 - Hazards and cascade effects considered for the Naples case study (see also WP3)

2. Italian administrative structure

Italy has a population of about 60 million people (59,464,644, ISTAT 2011) and a total terrestrial area of just over 300,000 km² including Sicilia and Sardegnia, the two largest islands in the Mediterranean. Italy has the largest cultural heritage in the world with 3,400 museums, 2,100 archaeological areas, and 43 UNESCO sites. It has a high percentage of mountains (35%) and hills areas (42%).

The country is divided into 20 administrative regions, 110 provinces and 8,104 municipalities (72% with a pop. < 5000). Many municipalities are remote, sparsely populated and possess very limited resources for public services, yet their locations are often highly exposed to natural hazards. The Italian regions vary greatly according to their size, population, cultural and linguistic characteristics, productive capacity of their economic activities and the types of natural hazards to which they are exposed.

From the administrative viewpoint, there are 3 broad categories of competences: the exclusive legislative competency of the state, the shared legislative competency between state and regions, and the residual legislative competency of the regions. The Italian Constitution of 1947 established a principle of decentralization of certain powers to Regions (art. 116). These were distinguished in Regioni a Statuto Speciale, also known as Regioni Autonome (Special Statute Regions or Autonomous Regions), and Regioni a Statuto Ordinario (Ordinary Statute Regions). The former were established during the early years of the Republic (Sicily in 1946; Sardinia, Valle d'Aosta, and Trentino-Alto Adige in 1948; and Friuli-Venezia Giulia considerably later, in 1963). The Ordinary Statute Regions have been implemented only in the seventies (laws and decrees regarding decentralization were passed in 1970, 1972, 1975 and 1977) and almost completed with Law Decree 112/1998.

More recently the Constitutional Law 3/2001 has turned over the previous constitutional framework, which assigned only a few competences to the “Ordinary Statute Regions” legislative power. The new text lists the competences at national level, leaving the remaining ones to the regions, which are even more extended in the five with a special statute of autonomy. In this highly decentralized system of public administration, coordination between
the national and regional levels of the administration is granted by the Conferenza Permanente Stato-Regioni (Permanent Panel State-Regions).

3. Mixed top down/bottom up management approach

Following the national process of administrative reforms described in the previous section, regions, provinces and municipalities have responsibility for risk and emergency management within their territorial areas. Government services at central, regional, provincial and municipal level are structured to coordinate their operations and resources with nongovernmental actors through a mixed top-down, bottom-up organizational system that strategically integrates capabilities at short notice and in real time (OECD 2009).

The National Civil Protection Service (NCPS) provides a legally recognized, institutional form to the numerous actors belonging to the risk/emergency management system. It is like an umbrella institution which guarantees national coordination of the different disaster management activities on the field and act as an external organ of the Environment Ministry.

The official mandate of NCPS is to protect human lives, health, economic assets, cultural and architectural heritage, human settlement and the environment from any kind of disaster, either natural or man-made (law 225/1992, last update law 100/2012).

In most European countries, these tasks are performed by only one institution or a few public bodies. In Italy, instead, the entire State organisation is involved, at national, regional, provincial and municipal level. Indeed the National Civil Protection represents the umbrella under which all the different agencies and organizations dealing with these issues are collected. Even civil society fully participates in the Civil Protection National Service, mainly through volunteer organizations.

After a new legislation in the year 2010, the Department of Civil Protection, i.e. the managerial body of the NCPS, is structured in seven offices: volunteers, education and communication; hydro geological and atrophic risks; seismic and volcanic risk; emergency management; administration and budget; human and instrumental resources; aeronautic activity (DPCM 8394/2010; law decree 113/2011). Each office is divided in a number of services. As we will describe in the following, this restructuring gives a clear role to the National Service for coordinating the local agencies and services.

As we will see also in the following chapter, the role of NCPS is very different depending on the phase of the disaster/risk cycle and the magnitude of the event.

One of the key principles on which the disaster management system is based is subsidiarity, i.e. in each municipality the mayor is responsible for civil protection and organizes human and economic resources according to a pre-established municipal emergency plan. The latter is designed to cope with all the risks that might occur in the municipality territory. The support of provinces and regions as well as the assistance of central government administrations, co-ordinated by the prefects, is brought to bear when local capacity is insufficient to manage the scale of the event.

Three different types of events are usually foreseen:

**Type A**: events that can be managed by municipal authorities as part of their routine duties;

**Type B**: events that require coordinate intervention of more authorities at provincial and regional level, as part of routine duties;

**Type C**: events of great intensity and extent that require coordination and intervention at national level.
The central government maintains its role of providing general orientation and coordination in the field of civil protection, but the regions and the local institutions are responsible for the preparedness and management of ordinary emergencies at the local level. In the most serious events (type C), a national level integration will take place and emergency forces available on the spot will unite with any other staff and equipment necessary to meet the needs effectively. More precisely, the Council of Ministers, on proposal from the President of the Council, deliberates on the state of emergency, determining its duration and extent strictly with respect to the quality and nature of the events. Emergency interventions are implemented following this declaration, also using appropriately motivated legal dispensations, though in compliance with general legal principle.

Box. The evolution of the National Civil Protection System in Italy

The Italian Civil protection System is one of the key agencies dealing with natural risk management in Italy. Along the years, the Service has been restructured several times, in a continuous alternation between devolution and centralization tendencies. Civil Protection evolved out of the field of Civil Defence, on the basis of experience gained in civil operations during the Second World War, with the aim of protecting non-combatant populations against military attack. One of the first royal decrees regarding Civil Protection was issued in the year 1926 and aimed at guarantee safety and assistance to the local population in case of need (RDL 0971271926 “First aid services in case of seismic events or other disasters”). This field gained a major importance in the 1960-70s as a result of preparedness to resist nuclear strikes and it started to take a new form associated more closely not only with natural, but also with technological disasters (Alexander 2002). In 1970, a key law (996/1970) described the tasks of rescue services and transferred the competence of these problems from the Minister of Public Works to the Minister of the Interior. In this way, the emergencies were not seen any more as technical problems but rather as problems of public order (Pellizzoni, 1992). The law created within the Ministry of the Interior an Interministerial Committee for Civil Protection and a Technical Interministerial Commission composed of the representatives of the state administrations and the affected local communities. It also introduced a “government delegate commissary”, provided with exceptional powers, for a unitary management of all bodies, administrations and public and private resources involved in an emergency. From that moment on the figure of the delegate commissary represents a key actor in emergency and post emergency management. Law n. 996 identified the fire brigades as the principal force for initial rescue work in disasters and the provincial prefectures as the source of direction for emergency relief efforts. It also established the Civil Protection Volunteer Service (Lundstrom, 2003; OCSED 2009).

The first comprehensive and detailed outline of the Italian Civil Protection system was set up in the 90’s, with the law 225/1992 which is still (in 2012) one of the key regulatory acts regarding civil protection actions (last update law 100/2012). One of the main aims of this law was to establish a flexible emergency response (but not without decisive leadership). The operational structures are the fire brigades, army, the police forces, the forestry national service, the national technical services, some institutions and groups of scientific research, the Italian Red Cross, the structures of the National Health Service, the voluntary organizations, and the national Alpine rescue service. Moreover the regions, the provinces, the prefects, and the mayors share the responsibility for civil protection actions at different levels. One peculiarity of the Italian system of Civil Protection is that even citizens and members of voluntary organisations are formally part of it. Before and after the beginning of the new Century the status of the Civil Protection varied several times. Much responsibility for it had gone to the regions and provinces as part of the devolution process, implemented by the law decree n.112/1998 (also called Bassanini law decree). The Chapter VIII of this decree is dedicated to Civil Protection and set out the rules for decentralising the system. As reported by Alexander (2002), this was considered as a necessary step: “it had become abundantly clear that a national structure could not play an adequate coordinating role unless
it was complemented by strong levels of organisation at lower levels of government. The decree-law therefore obliged regions and provinces to play a coordination role for the civil protection activities of municipalities. The regions, in particular, are to have a fundamental role in training disaster managers and will act as intermediaries between central and local government.” (Alexander 2002: 178)

Other changes regarded the organization of the Civil Protection. In 1999, measures were enacted to establish an agency (law decree n. 300/1999). For three months in early 2000 the agency actually existed, and then it succumbed in 2001. In the same year, the Constitutional law 3/2001 established the principle of horizontal subsidiary within the public and private sector by increasing the role of individuals, associations and business enterprises. As a result, the level of coordination between civil protection authorities, volunteer organisations, utilities and critical infrastructure operators had to be implemented and legislation about Civil Protection became a regional competence. The law decree n. 343/2001 (“Urgent measures to ensure coordination of the structures in charge of civil protection activities”) gave more power to the President of the Council of Ministries for the management of emergencies and “big events”. Moreover the decree entrusted the Head of the Civil Protection with the coordination of public and private authorities dealing with emergency management. Another law in 2002 (l. 286/2002) conferred full authority on the Prime Minister to undertake actions upon the outbreak of an extraordinary emergency situation, thus centralising the emergency management.

It is important to mention that in the new legislative framework enacted in the year 2010, 2011 and 2012 (DPCM 8394/2010; law decree 113/2011; law 100/2012), the National Department of Civil Protection took on more responsibility for the supervision of the activities of the different bodies and agencies. Two of the seven offices (volunteers, education and communication; hydro geological and atrophic risks; seismic and volcanic risk; emergency management; administration and budget; human and instrumental resources; aeronautic activity) established after the new laws’ enactment are dealing with the risks under study:

- Seismic and volcanic risk: the office elaborates and proposes criteria and methodologies, develops analysis for the evaluation and mitigation of seismic and volcanic risk, for the impact forecast of seismic and volcanic risk on the territory, for the optimization of emergency works and post event reconstruction as well as for prevention plans and programs, seismic classification and legislation. It is divided in several services: i) seismic hazard and risk; ii) vulnerability, legislative aspects and mitigation works; iii) post event technical management; iv) seismic monitoring of the territory; v) volcanic risk;

- Hydrogeological and anthropic risk: the office carries out activities of forecast, evaluation and prevention for hydraulic, hydrogeological, environmental, technological risks as well as forest fires. Provides technical support for the activities of the National Commission for Major Risks forecast. It is articulated in several services: hydro and meteo; hydro geological, hydraulic, hydro, maritime and coastal risk; environmental risk; technological risk; forest fires; technical monitoring of structural measures and post emergency actions.

In short, as the laws mentioned so far show quite clearly, before and after the beginning of the new Century there has been a constant tension between centralising tendencies and the forces of devolution. The last development will be better described in the following parts of the report.
4. Organisation

In this chapter we describe the general architecture of the risk management system which is common for all the hazards/risks under study. We distinguished the following phases:

- **risk assessment and prevention**: actions to study and determine the causes of calamitous phenomena, to identify risks and pinpoint local areas subject to the same risks;
- **early warning and forecast**: actions to avoid or minimise the possibility of damage arising from natural calamities, catastrophes and calamitous events on the basis of knowledge acquired by forecast.
- **emergency management and relief**: interventions to ensure that the population affected by calamitous events receive initial assistance.
- **recovery**: implementation, as coordinated with the competent institutions, of necessary non-deferrable initiatives to remove obstacles to the recovery of normal living conditions.
- **education and communication**: activities aimed at raising awareness, facilitating the two-way exchange of information between authorities and public, etc.

4.1 Risk assessment and prevention

The Ministry of the Environment, Land and Sea Protection – (MATTM) determines trends and policies and coordinates the actions of the different authorities. The Presidency of the Council, acting under the coordination of the Environment Ministry and by agreement of other Ministries and Departments (Infrastructures, Transport, Agriculture and Forestry Policies, Cultural Assets and Activities; of the Department of Civil Protection and the Department of Regional Affairs and Local Autonomies) sets out guidelines for land use planning for areas at risk.

The National Department of Civil Protection is in charge of the preparation of guidelines for legislation relative to risk prevention as well as of the distribution of funds for risk mitigation to regions and other local authorities.

Hazard, risk and vulnerability assessment activities are supported by the network of Competence Centres, i.e. institutions that provide scientific and technical expertise about the nature of hazards, vulnerability of population and assets, and the development of technical measures to reduce them (OECD 2009): universities, national research centres and local authorities are part of this broad network.

The Competence Centres (law decree 3593/2011) are listed in table XXY. The table reports only the centres with competences regarding the natural hazards under study. Some competence centres have competences only for some hazards and we will report on them in the following sections. In general the activities of many Competence centres (as for example the Meteorological Service of the Armed Forces, the Italian Space Agency) regard not only risk assessment and forecast but also forecasting and risk mitigation. In short they cross different phases of risk governance.
## Tab. 1.1 - Tasks and functions of the competence centres in charge of risk assessment

<table>
<thead>
<tr>
<th>Competence centre</th>
<th>Tasks and functions</th>
<th>Hazards/risks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Administrations/Agencies</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISPRA Institute for environmental protection and research</td>
<td>• seismic risk: cooperates for the evaluation of environmental damage after earthquakes • hydro-geological risk: supports the offices of risk prevention and assessment • share of data and information about environmental risks, also in real time, and technical support for risk mapping and emergency plans</td>
<td>All</td>
</tr>
<tr>
<td>Infrastructure and Transport Ministry – General Directorate for dikes and hydro and electric infrastructures</td>
<td>Functional centres network support through: • the analysis of hydrologic and hydraulic phenomena • the identification of hydraulic-hydrological risk indicators for dikes constructions • monitoring of dikes (through a real time model)</td>
<td>Hydro-geological</td>
</tr>
<tr>
<td>Italian Space Agency</td>
<td>• develops applications and provides products and services based on satellite systems for the activities of the National Service of Civil Protection (forecasting, monitoring, emergency management)</td>
<td>All</td>
</tr>
<tr>
<td>2 Regional Agencies for Environmental Protection – Emilia Romagna and Piemonte</td>
<td>Support the national service for: • meteorological forecast on the entire national territory • elaboration of forecast models • development and management systems to elaborate the radar meteorological data • development of tools and methodologies to identify risk areas and define warning zones, also to evaluate the critical levels for the national territory</td>
<td>All</td>
</tr>
<tr>
<td>Roma - Local Health Agency</td>
<td>• deals with the effects of climate on health • promotes research activities and a forecasting system for heat waves</td>
<td>Climate change related hazards</td>
</tr>
<tr>
<td>National office for Civil Aviation</td>
<td>• defines the procedures and intervention plans to guarantee safety in the transport of goods and people</td>
<td>All (focus on fires)</td>
</tr>
<tr>
<td>AGEA - Agriculture Agency</td>
<td>• builds and updates the data for soil use or for analysis and mapping of phenomena related to the forestry or agricultural territory such as soil erosion, forest fires, and monitoring</td>
<td>Landslides and fires</td>
</tr>
<tr>
<td>National Institute for Geophysics and Volcanology – National group for Volcanology – National group for earthquakes defence</td>
<td>• seismic and volcanic monitoring, technical-scientific consultancy, seismic and volcanic risk studies on the national territory • responsibility for seismic hazard overall the national territory through instrumental networks on the national territory or concentrated around active volcanoes • maintenance of an effective first aid network • transfer of scientific and technical data to the National Major Risk Commission • prepares and develops a research programme to obtain a better knowledge of the possible scenario of seismic and volcanic hazards</td>
<td>Earthquakes and volcanoes</td>
</tr>
<tr>
<td><strong>Research institutes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>National Research Centre</td>
<td>• develops knowledge, methodologies and technologies for national monitoring, forecast and surveillance systems. Coordinates the activities for the conventions with other research institutes</td>
<td>All</td>
</tr>
<tr>
<td>Institute for the science of climate and atmosphere</td>
<td>develops and verifies methodologies to use satellite data and for their application in the hydro geological sector (especially precipitation, soil humidity and snow)</td>
<td>Hydrogeological</td>
</tr>
<tr>
<td>Research Institute for Hydro geological Protection (IRPI)</td>
<td>develops methodologies to identify triggering factors and develop models</td>
<td>Hydrogeological</td>
</tr>
<tr>
<td></td>
<td>landslide hazard and hydro-meteorological thresholds evaluation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>identification, mapping and monitoring in real time of risk scenarios related to fast and localized mass movements</td>
<td></td>
</tr>
<tr>
<td></td>
<td>use of monitored data</td>
<td></td>
</tr>
<tr>
<td></td>
<td>scientific consultancy and research</td>
<td></td>
</tr>
<tr>
<td>Institute of environmental analysis methodologies</td>
<td>develops methodologies to integrate satellite data in the forecast system for forest fires and to monitor volcanic clouds,</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>integrates in situ techniques with remote sensing to estimate parameters of climatological or hydro-meteorological interest</td>
<td></td>
</tr>
<tr>
<td>Institute for water research</td>
<td>evaluates and manages crises and emergencies regarding water resources, pollution, legislative analysis of water issues</td>
<td>Hydrogeological</td>
</tr>
<tr>
<td></td>
<td>prepares and develops methodologies, analytical models and procedures to be used on real time in the Functional centre to define the damage scenario.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>prepares guidelines for risk mitigation and management</td>
<td></td>
</tr>
<tr>
<td>Institute of environmental geology and geo-engineering</td>
<td>develops guidelines and operative procedures for hydro geological and hydraulic risk, also in cooperation with other competence centres</td>
<td>Hydrogeological</td>
</tr>
<tr>
<td></td>
<td>coordinates other technical-scientific agencies for geological, hydro geological and geochemical risk evaluation,</td>
<td>seismic</td>
</tr>
<tr>
<td></td>
<td>identification, evaluation and monitoring of dangerous factors in vulnerable areas</td>
<td></td>
</tr>
<tr>
<td></td>
<td>develops methodologies for spatial models and scenarios related to seismic micro zoning as well as hydrogeological and geochemical risk</td>
<td></td>
</tr>
<tr>
<td>Biometeorological institute</td>
<td>works on climate change issues, including the assessment of the evolution and climatic instability as well as the anomalies of the key meteorological parameters</td>
<td>Climate change</td>
</tr>
<tr>
<td></td>
<td>develops tools and methods, defines regional scenarios with downscaling technologies and using models developed by the key international research centres</td>
<td></td>
</tr>
<tr>
<td></td>
<td>develops a seasonal forecast system focused on temperature and precipitation anomalies</td>
<td></td>
</tr>
<tr>
<td>Institute for building technologies</td>
<td>verifies the building constructions and their structure in case of earthquakes and for the safety measures of damaged buildings</td>
<td>Earthquakes</td>
</tr>
<tr>
<td>European centre for training and research in earthquake engineering</td>
<td>promotes, supports and sustains training and research in the field of seismic risk mitigation</td>
<td>Earthquakes</td>
</tr>
<tr>
<td></td>
<td>prepares guidelines and normative documents for seismic engineering</td>
<td></td>
</tr>
<tr>
<td></td>
<td>verifies technologies to reduce seismic risk</td>
<td></td>
</tr>
<tr>
<td></td>
<td>promotes education activities, also at international level, to develop data base and scenarios</td>
<td></td>
</tr>
<tr>
<td>World Health Organisation centre “Environment and health”</td>
<td>undertakes risk perception studies</td>
<td>Environmental risks</td>
</tr>
<tr>
<td></td>
<td>monitoring and health impact of risk situations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>analyses the key methods used by international agencies and organizations to evaluate environmental and sanitary risks, participation in</td>
<td></td>
</tr>
<tr>
<td><strong>University</strong></td>
<td><strong>Earth science department – Firenze University</strong></td>
<td><strong>International center of environmental monitoring</strong></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>international workshops  • elaborates guidelines on risk communication and management  • reports on citizen demand for public participation in the evaluation of environmental and health risks</td>
<td>develops and organizes the national monitoring and surveillance system for hydro geological risk  • sets methodologies to identify triggering factors and related models and scenario  • develops hazard assessment, mapping, monitoring and real time analysis of risk scenario  • localized analysis and monitoring of risky areas with sensors  • volcanic risk monitoring and surveillance (Stromboli)  • educational activities for the national department of civil protection or the regions</td>
</tr>
<tr>
<td></td>
<td>Hydrogeological risk/volcanic risk</td>
<td>All</td>
</tr>
</tbody>
</table>
| Federico II Naples University | risk  
- analysis of the impacts of these phenomena on buildings and people |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural and geotechnical engineering department of the Torino Polytechnic</td>
<td></td>
</tr>
</tbody>
</table>
- develops procedures for the geotechnical characterization of the soil with regard to geological, hydro geological, hydraulic and seismic risk  
- elaborates predictive models and simulation numerical models for the analysis and interpretation in real time, in a GIS environment, of the instability phenomena, more precisely landslides and hydro geological models  
- traditional monitoring, deep and in surface, and distance control |
| River Basin Authorities |  
- develops procedures for flood risk management and for effectively linking it to emergency planning at different scales  
- develops models for forecasting and controlling floods all along the river (which crosses several Italian regions) |
| Interregional agency for the Po river | Hydrogeological  
- develops procedures for flood risk management and for effectively linking it to emergency planning at different scales  
- develops models for forecasting and controlling floods all along the river (which crosses several Italian regions) |
| 5 River Basin Authorities (Arno, High Adriatic, Liri garigliano, Po, Tevere) | Hydrogeological  
- develop procedures, methodologies and techniques for assessment, emergency planning, floods control and forecast (focus on geological, hydrogeological and hydraulic risks)  
- develop monitoring systems, also in real time  
- develop hydraulic modelling system for flood forecast and control |
| Big alpine lakes regulatory bodies | Hydrogeological  
- hydrologic monitoring of rivers, lakes and rain  
- coordinates hydraulic monitoring  
- support the elaboration of regulatory plans for floods and outflow regulation |

At the local level, **Regions, Provinces and Municipalities** are responsible for the enforcement of land-use planning and building constraints related to risk assessment.

### 4.2 Early warning and forecast

The National Department of Civil Protection (DPC—under the Presidency of the Council of Ministers) coordinates actions of forecasting and early warning at national level. Scientific research and innovation has shown the fundamental role of forecasting and surveillance systems, the importance of real-time data acquisition, their processing and immediate

---

5 By early warning systems one means the set of procedures which provides effective real-time information allowing institutions and civilians involved in a natural event to react preventively to the risk. Early warning consists of four main elements: i) situation monitoring; ii) forecast of imminent events (processing data and application of forecast models ); iii) notification of warning codes to institutions and the population; iv) response (protection and/or evacuation). Setting up and managing an early warning system is part of a set of activities aimed at reducing or zeroing the risk level, which fall within the strategies and procedures to reduce vulnerability, by preventing or limiting, through a forecast phase, the negative impact of events.
dissemination to all those involved in the forecast and management phases of the emergency situations.

The national system for surveillance and alert has a distributed architecture, i.e. consisting of state and regional functional centres, interconnected to form an exchange and processing network of all information concerning real-time hydro-meteorological forecast and monitoring supporting the Civil Protection.

At the national level, guidelines are defined and indicated for setting-up warning systems for hydrogeological risk. As regards volcanic and seismic risk, there are no specific guidelines. For volcanic risk, national emergency plans have been drawn up, which specify the characteristics of the monitoring system and procedures to be activated according to the alert level reached. With regard to seismic risk, alarm management systems are being developed for early warning systems and immediate post-event alert called “Seismic Alert Management System” (SAMS).

The organisational structure of the national alert system (defined in the PCM Directive of 27/02/2004, modified by the DPCM of 25/02/2005) responds to the need for clarity and general certainty in responsibility procedures. The duties and functions of a national distributed warning system (Law no. 401/2001 and in compliance with the Legislative Decree no. 112/1998) are assigned to the various actors involved:

- the State, through the Civil Protection Department;
- the Government’s local offices;
- the regions, through the presidents of the regional councils and the offices and regional services both of forecast and prevention and of emergency management.

Management of the national alert system is guaranteed by the Civil Protection Department, the regional authorities and the self-governing provinces through the network of Functional Centres, as well as the regional structures and the Centres of Competence called upon make up the network, which shall operate according to common criteria, methods, standards and procedures.

The Functional Centres are forecasting and monitoring services at regional level (supplemented by the National Functional Centre in Roma) which are dedicated to prevision and surveillance of hydrological, meteorological seismic and volcanic phenomenon for the purpose to support the decisions of civil protection authorities with hard data. The centres monitor and analyse, with a multi risk approach, data of critical situations - not only in Italy but also abroad - and formulate in real time the event scenarios in order to define civil protection interventions.

The National Functional centre in Roma is divided in three main branches: hydro geological risk, volcanic risk and forest fires. Functional centres work closely together with Competence Centres. The link between them is based on contracts with the aim of supplying necessary services throughout the year. Some of the Competence centres carry out monitoring activities in real time, for instance the National Institute for Geophysics and Volcanology (INGV)’s and the national seismic network and UNIFI for SAR monitoring of the Stromboli volcano.

The aim of these Centres is to provide a continuous service throughout the year and, if necessary, throughout each day, both to support the decisions of the authorities charged with emergency warning and management, as well as perform the operative requirements of civil protection systems. The system includes 21 Functional Centres, one per region or autonomous province, and a National Centre. At present, 11 Functional Centres are at least partly operative.

Regarding the hydrogeological risk, the Functional Centre basically operates in two phases:
• a forecast phase to assess the expected meteorological situation and predict its effects on soil by interpreting the simulations of numerical models, consisting of the following steps: forecast of meteorological events (wind, rain, snow, ice, etc.); forecast of the expected residual risk and the effects that the occurrence of such events would cause on human lives, property, housing and the environment in the areas assigned to each Functional Centre; assessment of the critical level, obtained by comparing the forecasts with the adopted thresholds;

• a surveillance and monitoring phase to provide information by means of transmission, collection and concentration in the Functional Centres of data recorded for various purposes by different sensors. Such information allows the predicted scenario to be formulated and/or confirmed, and permits updating while the event evolves. This phase therefore involves the following activities: qualitative and quantitative observation, both direct and instrumental, of the meteorological, hydrological and hydrogeological event under way and short-term forecast of the relative effects.

In order to assess the meteorological situation, for the purposes of the National Civil Protection Service, the Department guarantees, by 12:00 on each day, brief weather forecasts for the following 24, 48 and 72 hours to allow:

• individual meteorological services or weather forecasting sections of the regional Functional Centres to produce and effectively interpret forecasts for their area and thereby proceed to model the various effects on the soil;

• the Department to publicly release a national bulletin of daily meteorological vigilance and a confidential national bulletin of critical states;

• the Department, as well as the autonomous regions and provinces, to release confidential warnings of adverse weather conditions and both national and regional critical states.

For forecasting and prevention purposes, the autonomous regions and provinces in agreement with the Civil Protection Department have subdivided and/or aggregated the river basins of their own competence, or parts of them, into significantly homogeneous areas for the expected real-time occurrence of the type and severity of intense meteo-hydrological events and their relative effects; these areas are called Alert Zones. In each zone and for each hazard type, suitable precursors and their values shall be identified regarding the probable occurrence of the scenarios and the effects on human lives, property, housing and the environment. This identification must be obtained both on the basis of historical knowledge and trends over time and in the area of significant events and their relative effects, and from modelling the events and their most probable effects.

The autonomous regions and provinces, as agreed with the Department, establish a set of indicator values which, individually or jointly, define for each risk type a system of thresholds on two levels (moderate and high, besides an ordinary baseline, in which possible critical situations are deemed to be widely acceptable on the part of the population). Following a warning of adverse weather conditions, the autonomous regions and provinces declare their assessments of the critical level expected in the various alert zones into which the region is classified.

It is the task of the autonomous regions and provinces to ensure that on reaching and/or exceeding such thresholds, the civil protection system alert levels are planned:
• before the occurrence of the event, in the activation phases of the preventive systems, as well as the phase of emergency preparation;
• during and after the occurrence of the event, in the phase of emergency management and recovery.

Adoption and declaration of the civil protection system of the various alert levels on the basis of the critical levels reached, and hence activation of the various phases of the provincial and municipal emergency plans, is the task of the President of the Regional Council or his/her delegate pursuant to the relevant regional legislation.

It also depends on the type of event (A, B or C). If it’s a type A event, once the mayor has received the notice of a threshold overcoming from the Region or the Prefect, it should be up to him to declare the corresponding alert level after an internal consultation with the responsible person of the Municipal Civil Protection.

The legislation requires the autonomous regions and provinces to promote and maintain the organisation of the area offices for surveillance and urgent technical intervention, as far as possible also on a municipal scale, and ensure the possible participation of State and voluntary organisations, the public and private agencies for reclamation, soil and area defence, management of hydraulic works and irrigation water regulation, as well as the management of road and railway transport as well as that of energy.

The National Commission for the Forecast and Prevention of Great Risks and the Public Weather Forecast and Meteorological Service – managed by the National Air Force (NCPS) – give support to the Head of the Department of Civil Protection at national level. The former meets at the Civil Protection Department. It is organised into divisions and undertakes technical and scientific consulting in respect of forecasting and preventing various risk situations. It is chaired by the President of the Council of Ministers or, in his/her absence, by his/her delegate and consists of the Head of the Civil Protection Department, acting as vice-chairman, who replaces the President in the event of absence or impediment, of an expert in civil protection issues, experts in various risk sectors, two experts appointed by the Environmental Protection Agency (APA) and two experts appointed by the Permanent Conference for relations between the State, the regions, autonomous provinces of Trento and Bolzano, as well as a representative of the National Voluntary Civil Protection Committee, nominated by decree of the President of the Council of Ministers.

The forecasting system of the National Air Force is the official source of data for spreading alert and emergency messages, it works on a very broad scale and thus might be not always very accurate.

Forecasting is performed on a regional scale and thus more accurately by the Regional Agencies for Environmental Protection (ARPAs). These agencies however are not evenly spread across the national territory. Whereas the regions of Northern Italy all have an ARPA, this is not the case for all central and southern regions, where functions of ARPA may be covered by private companies (Bianchizza et al., 2011).

Radio and television weather forecasts receive their raw material or data mainly from the Air Force but also from the ARPA and other sources and use it as they wish (OECD 2009). The NCPS has a strong capacity to exploit the meteorological as well as hydrogeological and seismic data and use them for real time forecast purposes, for early warning and alerting and in the operational information and decision support system.

The National Department of Civil Protection issues warnings to the public through the media and through the chain of command to all concerned. The Prefect informs local authorities and the mayor, the individual citizens and society in general.


4.3 Emergency management and relief

The National Department of Civil Protection coordinates the Government’s actions relative to emergency management, support, and rescue.

As already mentioned in chapter 4.3, a key distinction made in the Italian emergency system regards different types of events: ‘A’ and ‘B’ events can be managed through ordinary interventions implemented by bodies and administrations whereas ‘C’ events must be managed making recourse to extraordinary means and powers. The Prime Minister deliberates on the state of emergency if the event is deemed to be of ‘Type C’. The State of emergency is determined in its duration and territorial extent and is called off through the same procedure when conditions no longer require it. All the actions of emergency intervention can then be implemented through appropriately motivated legal dispensations. In case of a type C emergency, the operative committee of the civil protection collects 27 representatives of the public and private: apart from the already existing operational structures of the civil protection service, there are also representatives of research centres, phone and mobile companies, mass media, electric companies, railway companies, etc.

Tab. 1.2 - Operative organization of the civil protection system

<table>
<thead>
<tr>
<th>Type of event</th>
<th>Level</th>
<th>Operational committee</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>National</td>
<td>Major risk commission</td>
</tr>
<tr>
<td></td>
<td>National</td>
<td>National Operational room</td>
</tr>
<tr>
<td></td>
<td>National</td>
<td>Di. COMA. C (national coordination on site in case of major events)</td>
</tr>
<tr>
<td>Regional</td>
<td>Regional</td>
<td>Regional operational room</td>
</tr>
<tr>
<td>Regional</td>
<td>Regional</td>
<td>Crisis Unit</td>
</tr>
<tr>
<td>Provincial</td>
<td>Provincial</td>
<td>Rescue coordination centre</td>
</tr>
<tr>
<td>Municipal</td>
<td>Municipal</td>
<td>Municipal operational centre (COC) Strategy area, decisional function; Operative room</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>National</th>
<th>Regional</th>
<th>Provincial</th>
<th>Municipal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responsible Authority</td>
<td>Head of National Civil Protection</td>
<td>President of the region</td>
<td>Prefect</td>
</tr>
<tr>
<td>Operational centre</td>
<td>National operational room</td>
<td>ROR</td>
<td>COC</td>
</tr>
<tr>
<td>Di. COMA. C</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Operational room
14 functions
14 functions
14 functions
9 functions

Regions, Provinces and Municipalities prepare programmes for emergency forecasting, prevention and planning (e.g. general zoning plans, provincial coordination plans, civil protection emergency plans, etc.). At the local level, contingency plans and emergency response are co-ordinated by the Prefect together with the local Civil Protection services (at regional, provincial and municipal level).

The volunteers that work at municipal level are the backbone of the operative branches of Civil Protection. They are strongly rooted in the territory, usually well prepared and are the

---

6The Prefect is a State representative authority with responsibilities over public safety at the provincial level (L. 121/1981).
first to intervene when an emergency strikes. International networks of volunteer groups are also very important in case of emergency.

The key actors involved in the emergency management as well as their tasks and responsibilities are summarized in table here below. Besides them, other services and agencies act with specific responsibilities on single hazards. They will be described more in detail in the following sections.

Tab. 1.3 - Actors involved in emergency management and their tasks/responsibilities

<table>
<thead>
<tr>
<th>Actor</th>
<th>Tasks/Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Government</strong></td>
<td>The prime minister:</td>
</tr>
<tr>
<td></td>
<td>• has responsibility for emergency management</td>
</tr>
<tr>
<td></td>
<td>• has full authority to take action upon the outbreak of an extraordinary emergency situation</td>
</tr>
<tr>
<td><strong>National Department of Civil Protection</strong></td>
<td>protection of lives and assets from damage or possible damage due to natural and technological disasters.</td>
</tr>
<tr>
<td></td>
<td>• tasks: promoting and coordinating the disaster management system, intervening directly in case of type C events, defining common interventions and action</td>
</tr>
<tr>
<td></td>
<td>• procedures, directing the setting up and management of information networks necessary for risk prevention, producing and managing extraordinary regulations</td>
</tr>
<tr>
<td></td>
<td>• needed to conduct emergency interventions and deal with calamities</td>
</tr>
<tr>
<td><strong>Fire Brigade Corps</strong></td>
<td>• intervene in case of emergency, to protect the population and preserve the national cultural patrimony from any natural or man-made risk in the whole of Italy</td>
</tr>
<tr>
<td></td>
<td>• the corps are present at national, regional, provincial and municipal level</td>
</tr>
<tr>
<td><strong>Forest Corp</strong></td>
<td>• environmental monitoring and pollution control</td>
</tr>
<tr>
<td></td>
<td>• forest fire fighting as well as search and rescue operations in the forests and mountains</td>
</tr>
<tr>
<td><strong>Armed and Police forces</strong></td>
<td>The Armed forces - Italian Joint Operations Headquarters (COI) deploy forces from the Army; Navy; Air Force and Carabinieri. Police forces include: financial</td>
</tr>
<tr>
<td></td>
<td>• police; national, regional and municipal police; Financial Guard; Coast Guard provide assistance for the management of emergencies (e.g. immediate aid to rescue human lives, etc.)</td>
</tr>
<tr>
<td><strong>National Health Service</strong></td>
<td>• assesses needs and priorities for action to be taken and provides the information concerning human health, logistics and technological resources available in the area affected by the event, identifying their location, characteristics and equipment, time frame for action and modalities for use</td>
</tr>
<tr>
<td><strong>Volunteers</strong></td>
<td>support the other actors during emergencies</td>
</tr>
<tr>
<td><strong>Region</strong></td>
<td>• immediate activation and deployment of the regional emergency convoys and the volunteer organisations</td>
</tr>
<tr>
<td></td>
<td>• management of health care emergency operations, based on the regions’ own plans, in compliance with the main criteria and policies established by the prime minister concerning the management of health relief and rescue operations in crisis</td>
</tr>
<tr>
<td></td>
<td>• deployment of technical units to check the safety in buildings, survey the damage, evaluate remaining risks, undertake testing of drinking water quality</td>
</tr>
<tr>
<td></td>
<td>• management of radio networks for emergency communication (including volunteering organisations of radio amateurs)</td>
</tr>
<tr>
<td></td>
<td>• use of primary necessity goods stored under regional competence to provide assistance to the population</td>
</tr>
<tr>
<td></td>
<td>• activation of the regional operational room (ROR provides constant update of information to the national operations centre)</td>
</tr>
<tr>
<td></td>
<td>• The councillor (assessor) is a political appointee responsible for civil protection at regional level.</td>
</tr>
<tr>
<td></td>
<td>• The president of the region is:</td>
</tr>
<tr>
<td></td>
<td>• consulted by the Head of the Department of Civil Protection in case of the declaration of the state of emergency</td>
</tr>
<tr>
<td><strong>Province</strong></td>
<td>• establishment and implementation of the provincial emergency plan (sometimes in cooperation with provincial and regional authorities) including all the risks</td>
</tr>
</tbody>
</table>

WP6_Task 6.3
Emergency planning follows the so called **Augustus method**, which is the most organic, systematic tool for producing civil protection plans in Italy and, though it is by no means mandatory, it is configured as an optional tool of governance for the national emergency management system.

The strength of the method lies in its contents rather than its form. It has been developed grounding on the assumption that “**The value of planning decreases with the complexity of events**”. This sentence of Augustus emperor grasped 2000 years ago the essence of the concepts of **simplicity** and **flexibility** which today steer modern emergency planning.

This method was studied and created to define, elaborate, manage, verify and update emergency plans. The basic idea which inspired this method is that of the pointlessness of fine-tuned planning. It starts from the assumption that the actual event, however may be forecasted on paper, is always different from how it was imagined.

The guidelines of the Augustus method provide a blueprint for flexible emergency planning, depending on risk areas. The aim was to identify a simplified working method to implement procedures to effectively coordinate civil protection response. This underpins planning at all levels of responsibility (Città della Scienza 2004).

### 4.4 Recovery and reconstruction

The Italian government intervenes directly in case of emergencies by providing ex post financial aid and enacting *ad hoc* measures. No private insurance scheme is available for covering disaster damage.
In most cases, State indemnification of disaster losses follows a routine procedure. Whenever a natural catastrophe involves a given area, the Regional government proposes the declaration of the state of emergency for that particular area, which may involve the territory of a town, of a province or of an entire region according to the extent of the disaster (Monti and Chiaves 2006). The Cabinet of Ministries must approve the proposal for the state of emergency to be officially declared. Approval opens the way to governmental interventions.

Usually the President of the Region establishes an ad hoc commission to undergo the evaluation of damages and monitor reconstruction works. The Department of Civil Protection acts as an intermediary and technical expert body throughout the process and has a leading role in the reconstruction phase.

The debate over the introduction of a private or mixed public / private insurance scheme is heated at the national level. As reported by Monti and Chiaves: “A relevant share of the State’s yearly budget is devoted to restoring damage incurred as a result of catastrophes. In the absence of an organic set of rules of reference or legal guidelines, State funding is basically inspired by provisions aimed at covering emergency situations connected to specific unexpected disastrous events, so that ad hoc provisions were enacted which varied consistently in time and were characterised by being excessively discretionally (...). At the same time, the enactment of special laws and provisions indemnifying the owners of properties affected by single disasters generated a sort of reliance on the Government by Italian citizens, who know they may always count on the state for recovery, which is one of the reasons why private insurance covering natural disasters has never fully developed in Italy.” (Monti and Chiaves 2006: 171)

4.5 Education and communication

In regard to the promotion of risk awareness and preparedness, each Prefecture, as a national authority, is in charge of providing information to the population. Locally, it is the municipality that has to communicate appropriate behaviours to be enacted in case of an emergency. Each municipality has to prepare an emergency plan including all the indications needed in case of emergency (e.g. warning and evacuation procedures). Each municipality has a Municipal Operations Centre (COC), in which managers of authorities and municipal operation units work together to define the intervention strategy, and an operations room organised by function.

The role of local volunteers is especially relevant, as they are obviously rooted in the territory, therefore acting as mediators between formal bodies of civil protection and population.

The National Department of Civil Protection organises simulation exercises of national relevance, coordinate activities and programmes to foster the culture of civil protection, and provides activities of risk education that schools can include in their curricula. These are also undertaken by volunteers of the local units of Civil Protection. Some projects are also created and implemented together with environmental NGOs.

Box. Civil protection volunteers in Italy

Voluntary organisations are one of the main pillars on which the Italian Civil Protection rests.

In 2010 the Italian voluntary system included 27 national organisations, 3,667 local volunteer organisations and 1,200,000 volunteers (i.e. almost 2% of the national population; Renzulli, 2010). At the national level 100-150 thousand volunteers can be mobilised within two hours.
To mention an example: the emergency planners of the city of Firenze “proudly boast that they can put 4000 civil protection volunteers into the field at two hours’ notice. It is not an empty claim. The city has a tradition of volunteer emergency services that is unbroken since 1334, when the Venerable Company of the Misericordia was founded. Nowadays, the Misericordia is an up-to-date ambulance service, which runs training courses in urban rescue techniques. It is supplemented by a wide range of similar organizations.” (Alexander 2002:5).

50% of the personnel involved in an operational response to a disaster may be volunteers (Declaration 194/2001). It is recognised in its organised forms by a national law (266/1991) and by successive regional laws.

Voluntary organisations that wish to cooperate in the public system of civil protection, are registered in special registers, at regional or national level. They are recognized as "national operational structures", and they are an integral part of the public system in the same way as other institutional components (Citta’ della scienza 2004).

Their tasks are the following: provide information about the event and the number of volunteers and resources that are active in the affected areas; plan for potential deployment of additional resources; called upon to participate, upon request by the competent authorities, in rescue operations of the population and all the necessary activities to reinstate ordinary living conditions (preparation and distribution of meals and shelter for the rescue team and the affected population).

5. **Single risk characteristics**

5.1 **Landslides and floods**

Systematic assessment of landslide/flood hazard, risk and vulnerability is performed by the River Basin Authorities, as stated by Article 12, Law 183/1989. At present there are 40 river basin authorities on the national territory. Six of them operate at national level, 13 at interregional, 19 at regional and 2 at provincial level.

Each Basin Authority is composed of (art. 12): a) the institutional committee; b) the technical committee; c) the secretary general and the technical-operational secretariat. The institutional committee is composed of several Ministries (or delegated under-secretaries): Infrastructures, Environment, Defence of the Territory and the Sea, Agricultural and Forestry Policies, Cultural Assets and Activities. Also members are the Presidents of the interested Regions and the Secretary general of the Basin Authority.

The activity of these Basin Authorities is coordinated at the national level by the Environment Ministry (MATTM), which also establishes plans and policies and allocates financial resources for their activities, namely the production of basin plans, hazard and risk maps and advice on prevention and mitigation measures.

The enforcement of the European Water Framework Directive (2000/60/EC) caused a new restructuring of the river basins in district basins. The Directive was officially acknowledged in the Italian legislation in the year 2006, with the law-decree 152/2006 which introduced the concept of hydrographic basins (i.e. streams, rivers and lakes which flow into the sea only with one mouth) and districts (i.e. soil or sea area which correspond to one or more hydrographic basins and their surface or underground waters, which constitute the main units for the management of hydrographic basins). The country has been divided in 8 hydrographic districts.
The decree 152/2006 stated the replacement of the river basin authorities with the new **District Basin Authorities**. All previous authorities were to withdraw in favour of these new district basin authorities, but unfortunately this did not happen. In 2009 a new law was promulgated (L.13/2009) which, in the absence of the district authorities, gave some national authorities the power to coordinate the elaboration of the district plans.

The evaluation of flood and landslide risk is conducted at the level of each hydrographic district. **Special Plans** (Piani Straordinari) include areas exposed to higher risks, as resulting from historical data, on-site evaluations and hazard/risk assessment. The **River Basin Plans** (PAI: Piani per l’Assetto Idrogeologico) comprise areas at high risk according to return periods that are compatible with those indicated in the EC “Flood Directive” (2007/60/EC). For landslide the term of reference is a national law 267/1998. These plans also contain indications concerning both structural and non-structural risk mitigation measures.

In the broader context of spatial planning, the River Basin Plans (together with park and landscape plans) are considered sectorial plans whose indications have to be included in the planning at regional, provincial and municipal level. Basin and provincial coordination plans have some shared objectives/competences, e.g. provide guidelines for hydrological, hydrogeological and forestry setting, define spatial distribution in risky areas, provide guidelines for local plans in risky areas.

More detailed hazard and risk maps may be produced by regional, provincial or municipal authorities on demand. The hydro-geological risk assessment is also aided by further data specifically produced by the Regional Agencies for the Environment, the National Research Council, and the different units (“Functional Centres”) of the National Department of Civil Protection or research centres of universities, following specific requests (Galderisi and Ceudach 2009; Galderisi and Menoni 2007; al., 2006, De Marchi et al., 2007, Scolobig, 2010).

A number of agencies, services, research institutes and universities cooperate in the activities for risk assessment and early warning. Here below we report those with responsibility only for hydro geological risk.

At the national level, guidelines are defined and indicated for setting-up warning systems for hydrogeological risk.

**Tab. 1.4 - Hydrogeological competence centres**

<table>
<thead>
<tr>
<th>Competence centre</th>
<th>Tasks and functions</th>
<th>Hazards/risks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Administrations/ Agencies</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infrastructure and Transport Ministry – General Directorate for dikes and hydro and electric infrastructures</td>
<td>Functional centres network support through: the analysis of hydrological and hydraulic phenomena the identification of hydraulic-hydrological risk indicators for dikes constructions monitoring of dikes (through a real time model)</td>
<td>Hydro geological</td>
</tr>
<tr>
<td>AGEA – Agriculture Agency</td>
<td>builds and updates the data for soil use or for analysis and mapping of phenomena related to the forest or agricultural territory such as soil erosion, forest fires, and monitoring</td>
<td>Landslides and fires</td>
</tr>
<tr>
<td><strong>Research institutes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institute for the science of climate and atmosphere</td>
<td>develops and verifies methodologies to use satellite data and for their application in the hydro geological sector (especially precipitation, soil humidity and snow)</td>
<td>Hydro geological</td>
</tr>
</tbody>
</table>
| Research Institute for Hydrogeological Protection (IRPI) | develops methodologies to identify triggering factors and develop models
| landslide hazard and hydro-meteorological thresholds evaluation
| identification, mapping and monitoring in real time of risk scenarios related to fast and localized mass movements
| use of monitored data
| scientific consultancy and research | Hydrogeological |
| Institute for water research | evaluates and manages crises and emergencies regarding water resources, pollution, legislative analysis of water issues
| prepares and develops methodologies, analytical models and procedures to be used on real time in the Functional centre to define the damage scenario
| prepares guidelines for risk mitigation and management | Hydrogeological |
| Institute of environmental geology and geo-engineering | develops guidelines and operative procedures for hydrogeological and hydraulic risk, also in cooperation with other competence centres
| coordinates other technical-scientific agencies for geological, hydro geological and geochemical risk evaluation,
| identification, evaluation and monitoring of dangerous factors in vulnerable areas
| develops methodologies for spatial models and scenarios related to seismic micro zoning as well as hydrogeological and geochemical risk | Hydrogeological/ seismic |
| University Earth science department – Firenze University | develops and organizes the national monitoring and surveillance system for hydro geological risk
| sets methodologies to identify triggering factors and related models and scenario
| develops hazard assessment, mapping, monitoring and real time analysis of risk scenario
| localized analysis and monitoring of risky areas with sensors
| volcanic risk monitoring and surveillance (Stromboli)
| educational activities for the national department of civil protection or the regions | Hydrogeological risk/volcanic risk |
| Laboratory of environmental cartography and hydrogeological modelling of the University of Calabria | develops mathematical models for real time forecasting of hydro geological events (especially for floods and real time landslides forecasting)
| develops methodologies to include provincial and regional warning systems into regional forecast and prevention programmes
| connects warning systems with risky area monitoring and emergency planning | Hydrogeological |
| Research centre “Geological risk” | studies triggering processes of gravitative phenomena and develops landslide models | Geological risk (focus on landslides) |
| Risk Forecast and Prevention | University of Roma | Provides landslide risk assessment  
  Develops research about geological risk experimenting innovative technologies |
|-----------------------------|-------------------|--------------------------------------------------------------------------------|
| Excellence Centre in Remote Sensing and Severe Events Forecasting Models of L’Aquila University | Develops operative chains of modelling and develops techniques for the evaluation of meteorological products  
  Develops new radar methodologies and technologies and elaborates the data for post evaluations  
  Monitors volcanic clouds |
| Laboratory for Hydrogeology Engineering of the Federico II Naples University | Research on hazard, risk and vulnerability assessment as well as on risk mitigation  
  Data collection for: buildings exposed to volcanic risk  
  Analysis of the impacts of these phenomena on buildings and people |
| Structural and Geotechnical Engineering Department of the Torino Polytechnic | Develops procedures for the geotechnical characterization of the soil  
  With regard to geological, hydro geological, hydraulic and seismic risk  
  Elaborates predictive models and simulation numerical models for the analysis and interpretation in real time, in a GIS environment, of the instability phenomena, more precisely landslides and hydro geological models  
  Traditional monitoring, deep and in surface, and distance control |
| Interregional Agency for the Po River | Develops procedures for flood risk management and for effectively linking it to emergency planning at different scales  
  Develops models for forecasting and controlling floods all along the river (which crosses several Italian regions) |
| 5 River Basin Authorities (Arno, High Adriatic, Liri Garigliano, Po, Tevere) | Develop procedures, methodologies and techniques for assessment, emergency planning, floods control and forecast (focus on geological, hydrogeological and hydraulic risks)  
  Develop monitoring systems, also in real time  
  Develop hydraulic modelling system for flood forecast and control |
| Big Alpine Lakes Regulatory Bodies | Hydrologic monitoring of rivers, lakes and rain  
  Coordinates hydraulic monitoring  
  Support the elaboration of regulatory plans for floods and outflow regulation |
5.2 Earthquakes

According to the legislative Decree 112/98, Regions are in charge of the identification, classification and updating of seismic areas basing on general criteria decided by the State. The National Ordinance 3274/2003 (“First general criteria for the seismic classification of Italy and technical regulations for constructions in seismic zones”) provided general criteria for seismic hazard mapping and a preliminary classification in four classes of national territory. After this ordinance, in July 2009, the new Italian Building code NTC08 came into force (Decreto 14/01/2008 Ministero delle Infrastrutture. Norme Tecniche per le Costruzioni, GU n. 29 del 04/02/2008). The code was mainly inspired by Eurocode 8, but it contains significant changes and improvements. First the concept of “seismic zone” is discarded and, based on the seismic hazard map, the seismic action (elastic response spectrum) is defined for each point of a mesh (10X10 km) covering all the territory. Second the Italian guidelines follow the so called Performance Based Seismic Design (PBSD) requiring the definition of different levels of seismic actions and performance criteria to be met by structures under each level of loading.

The differences in the regional legislation can be quite relevant. For example some regions require an integration of the national classification through in-depth analyses of seismic local hazard, vulnerability and exposure. According to the Emilia Romagna Planning Act (20/2000) all planning tools, regional, provincial and municipal ones, are required to contribute to seismic risk prevention and mitigation basing on hazard, exposure and vulnerability assessment. We will describe the legislation in another Region (Campania) in the following chapters.

With regard to monitoring and warning, earthquakes generally are abrupt phenomena, very difficult to be predicted. The National Institute of Geophysics and Volcanology (INGV) makes seismic monitoring activities together with a number of agencies, services, research institutes and universities. There are no specific guidelines, but an alarm management systems has being developed for early warning system and immediate post-event alert called “Seismic Alert Management System” (SAMS). Here below we report those with exclusive responsibility for seismic risk.

Tab. 1.5 - Seismic competence centres

<table>
<thead>
<tr>
<th>Competence centre</th>
<th>Tasks and functions</th>
<th>Hazards/risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Institute for Geophysics and Vulcanology – National group for Vulcanology – National group for earthquakes defence</td>
<td>seismic and volcanic monitoring, technical-scientific consultancy, seismic and volcanic risk studies on the national territory; responsibility for seismic hazard overall the national territory through instrumental networks on the national territory or concentrated around active volcanoes; maintenance of an effective first aid network; transfer of scientific and technical data to the National Major Risk Commission; prepares and develops a research programme to obtain a better knowledge of the possible scenario of seismic and volcanic hazards</td>
<td>Earthquakes and volcanoes</td>
</tr>
<tr>
<td>Institute of environmental geology and geo-engineering</td>
<td>develops guidelines and operative procedures for hydro geological and hydraulic risk, also in cooperation with other competence centers; coordinates other technical-scientific agencies for geological, hydro geological and geochemical risk evaluation,</td>
<td>Hydrogeological/ seismic</td>
</tr>
<tr>
<td><strong>Institute for building technologies</strong></td>
<td>identification, evaluation and monitoring of dangerous factors in vulnerable areas develops methodologies for spatial models and scenarios related to seismic micro zoning as well as hydrogeological and geochemical risk verifies the building constructions and their structure in case of earthquakes and for the safety measures of damaged buildings</td>
<td>Earthquakes</td>
</tr>
<tr>
<td><strong>European centre for training and research in earthquake engineering</strong></td>
<td>promotes, supports and sustains training and research in the field of seismic risk mitigation prepares guidelines and normative documents for seismic engineering verifies technologies to reduce seismic risk promotes education activities, also at international level, to develop data base and scenarios</td>
<td>Earthquakes</td>
</tr>
<tr>
<td><strong>University</strong></td>
<td>Network of university laboratories of seismic engineering</td>
<td>Earthquakes</td>
</tr>
<tr>
<td><strong>Structural and geotechnical engineering department of the Torino Polytechnic</strong></td>
<td>develops procedures for the geotechnical characterization of the soil with regard to geological, hydro geological, hydraulic and seismic risk elaborates predictive models and simulation numerical models for the analysis and interpretation in real time, in a GIS environment, of the instability phenomena, more precisely landslides and hydro geological models traditional monitoring, deep and in surface, and distance control</td>
<td>Hydrogeological/seismic</td>
</tr>
</tbody>
</table>

**Emergency management** is supported by three main surveillance seismic networks that rapidly improve the knowledge of a seismic event as soon as it occurs: the seismological network of INGV, the soil strong-motion network of the National Accelerometric Network (RAN) and the Seismic Structure Observatory (OSS) of the civil protection department. While INGV can provide full basic information on magnitude and location of an earthquake in a few minutes, the RAN and OSS networks provide more detailed remote data that enables DPC to evaluate the locally felt intensities (OECD 2009: 53).

With regard to **risk mitigation**, the focus of most of the legislation has been on improved building code provisions. The major cause of injury and death in earthquakes is the failure of buildings, so the goal was always to build structures in a way that they will, in current engineering practice, “fail gracefully”. However there seems to be a huge divide between legislation and its implementation, mostly due to the lack of economic resources. After the L’Aquila event in 2009, the decree n. 39 of 28/4/09 transformed in the law n. 77 of 24/6/09 (Art. 11), allocated a budget of 963.504 M€ in the years 2011-2016 for activities of seismic risk reduction in Italy and in particular:

- Seismic microzoning studies
• Vulnerability reduction of strategic and private buildings
• Urgent intervention

Funds are distributed among different Italian regions on the basis of a seismic risk index linked to the probability of building collapse and derived from the seismic risk maps. The main problem is that most of the building stock and public works in Italy predate modern seismic codes. The uptake of seismic zoning, where new construction is obliged to follow seismic codes, has been slow. Large scale development of public works proceeded very quickly in the period between the 1950’s and 1990’s while seismic zoning was mainly put in place after the 1980 Irpinia and the 2002 San Giuliano di Puglia earthquake. The result is that most of the existing buildings and public works are not adequately protected against the consequences of earthquakes.

5.3 Volcanoes

Activities to manage volcanic risk in Italy are conducted mostly at the national level by the Civil Protection Department, either directly or jointly with other agencies or Competence/Functional centres.

There are not specific guidelines for the warning, but national emergency plans have been drawn up, which describe the characteristics of the monitoring system and the procedures according to the level of alert.

Risk prevention measures include the emergency plans drawn up on the basis of one or more eruptive scenarios and corresponding hazard maps. The plan includes emergency actions and evacuation instructions for the local population (Citta’ della scienza 2004).

A number of agencies, services, research institutes and universities cooperate in the activities for risk assessment and early warning. Here below we report those with responsibility for volcanoes (DPCM 8394/2010; law decree 113/2011).

<table>
<thead>
<tr>
<th>Competence centre</th>
<th>Tasks and functions</th>
<th>Hazards/risks</th>
</tr>
</thead>
</table>
| Administra
tions/Agencies | National Institute for Geophysics and Volcanology – National group for Volcanology – National group for earthquakes defence | seismic and volcanic monitoring, technical-scientific consultancy, seismic and volcanic risk studies on the national territory |
| | | responsibility for seismic hazard overall the national territory through instrumental networks on the national territory or concentrated around active volcanoes |
| | | maintenance of an effective first aid network |
| | | transfer of scientific and technical data to the National Major Risk Commission |
| | | prepares and develops a research programme to obtain a better knowledge of the possible scenario of seismic and volcanic hazards |
| | Earthquakes and volcanoes |
| University | Earth science department – Firenze University | develops and organizes the national monitoring and surveillance system for hydro geological risk |
| | | sets methodologies to identify triggering factors and related models and scenario |
| | | develops hazard assessment, mapping, monitoring and real time analysis of risk scenario |
| | Hydrogeological risk/volcanic risk |
localized analysis and monitoring of risky areas with sensors
volcanic risk monitoring and surveillance (Stromboli)
educational activities for the national department of civil
protection or the regions

Excellence centre in remote sensing and severe events forecasting models of L'Aquila University
develops operative chains of modelling and develops techniques for the evaluation of meteorological products
develops new radar methodologies and technologies and elaborates the data for post evaluations
monitors volcanic clouds

Laboratory for hydrogeology engineering of the Federico II Naples University
research on hazard, risk and vulnerability assessment as well as on risk mitigation
data collection for: buildings exposed to volcanic risk
analysis of the impacts of these phenomena on buildings and people

5.4 Fires

From the institutional viewpoint, the Environment Ministry is responsible for the forest fire fighting sector. The assessment and planning in this area is based on guidelines issued by the Department of Civil Protection regarding forest fire emergencies and under the direct responsibility of the regions.

Each Region has the competence to organise its fire fighting system, including prevention and planning activities. Regional plans for forecast, prevention and active struggle against forest fires have to work out risk assessment, considering both predisposing factors and causes.

Mapping of the forests is planned on the regional level but implementation is on the local level which is obliged to assess the risk and have maps indicating the areas where there should not be commercial or residential exploitation of land. Vegetation features, geomorphologic and meteorological conditions, human factors (e.g. human behaviours), urbanization levels, road conditions and socio-economic features have to be taken into account. A municipal land register of the areas subjected to fire emergencies and local emergency plans with the respective interface areas have to be realized.

Fire fighting is carried out by ground teams in coordination with the National Forest Fires Air Fleet. The Unified Airborne Operations Centre (COAU) of the National Civil Protection is in charge of coordinating the National Air Fleet deployments upon request for assistance made by regional systems to DPC. The Forest Fire Corp Liaisons acting within the COAU are directly linked to all regional operational rooms, which are in charge of assessing fire situations and requests for support. COAU decides the National Forest Fires Air Fleet deployment strategy to meet requests from the regions.

A number of agencies, services, research institutes and universities cooperate in the activities for risk assessment and early warning. Here below we report those with responsibility for fires.
Tab. 1.7 - Competence centres for fires

<table>
<thead>
<tr>
<th>Competence centre</th>
<th>Tasks and functions</th>
<th>Hazards/ risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrations/ Agencies</td>
<td>National office for Civil Aviation</td>
<td>defines the procedures and intervention plans to guarantee safety in the transport of goods and people</td>
</tr>
<tr>
<td>AGEA - Agriculture Agency</td>
<td>-</td>
<td>builds and updates the data for soil use or for analysis and mapping of phenomena related to the forest or agricultural territory such as soil erosion, forest fires, and monitoring</td>
</tr>
</tbody>
</table>

5.5 Industrial risk

The risk of major accidents in industrial plants covers all the potential causes of accidents (release of toxic substances, fire and explosion) related to the presence (i.e. use or storage) in the plant of considerable amounts of hazardous substances which may give rise to serious danger, whether immediate or deferred, for human health or for the environment, inside or outside the plant.

The seriousness of this risk type is recognised by three European Directives (Directive 82/501/EC known as the Seveso Directive, Directive 96/82/EC known as the Seveso II Directive and Directive 2003/105/EC of 16-12-2003) and also required various legal provisions in Italy:

- Legislative Decree 17-08-1999, no. 334, “Implementation of Directive 96/82/EC with regard to the control of major accidents connected to certain hazardous substances”;
- DM 09-08-2000, “Guidelines for implementing the safety management system”;
- DMLLPP 09-05-2001, “Minimum safety requirements for urban and land use planning for zones with plants at considerable accident risk”.

According to the stipulations of Legislative Decree 334/99 and the Ministerial Decree of 9 August 2000, proper risk assessment must include identification of the accident scenario and analysis of its consequences so as to define a suitable safety programme which envisages every possible action in order to identify problems before they arise.

A fundamental aspect in planning terms is that of the domino effect. Explicitly introduced into legislation on industrial risk by Art. 12 of Legislative Decree 334/99, the domino effect consists in the possible sequence of perhaps different incidents which originate in a component of a plant and then extend to components nearby, due mainly to high heat radiation or over-pressure or fragment projection. This may affect both the equipment of a single process plant and that of neighbouring plants and/or stores.

In particular, concerning preventive post-event mitigation, under Presidential Decree of 25 February 2005 the Civil Protection Department laid down Guidelines for drawing up and updating External Emergency Plans (PEE) of factories with a major accident risk in pursuance of Legislative Decree no. 334/1999. What is established under Decree no. 334/1999 is the need to activate a series of actions to be taken by various public and private actors to prevent major accidents involving certain hazardous substances, and reduce and mitigate their consequences on human health and the environment.

This action concerning industrial plants with a major accident risk concerns:
notification, by the managing director of a new factory, to the Minister for the Environment, the regional, provincial, municipal authorities, the prefect and the regional or interregional technical committee of the National Fire Brigade, with information concerning the managing director and the main characteristics of activity carried out in the factory;

drawing up, by the managing director, a document defining management accident prevention policy, with an attached programme of action adopted to implement the safety management system.

Moreover, for industrial plants with a major accident risk in which external hazardous substances exceed high concentrations (Art. 8), the above action also entails:

drawing up, by the managing director, a Safety Report and an Internal Emergency Plan (PEI);

drawing up, by the Prefect, an External Emergency Plan (PEE).

As regards the emergency plans, it should be pointed out that PEIs are designed to identify the action to be taken, in an emergency, by the managing director and his/her employees, while PEEs organise and coordinate action and intervention of all actors involved in managing major accidents, in conjunction with the PEI. In particular, PEEs represent the official document with which the Prefect organises the civil and environmental protection response to mitigate the damage from a major accident on the basis of scenarios that identify the zones at risk most likely to be affected by the damaging effects of the expected event. The PEE is sent to the Ministry of the Environment and Land Conservation, the mayor, competent regional and provincial authorities, the Ministry of the Interior and Civil Protection Department. It is also sent to the managing director and actors involved in planning, activation and implementation of the same plan. The managing director also undertakes to notify the Prefect with due rapidity of the occurrence of events in the production process which could reasonably cause a “near-accident” or a major accident, so that the Prefect is alerted and has enough time to activate the PEE, thereby in a position to identify the civil protection systems most suited to safeguard human health.

The Ministry of the Environment draws up and updates, making use of the National Environmental Protection Agency (APAT), the inventory of industrial plants liable to cause major accidents and the data base on the assessment of the safety reports and safety management system.

The guidelines laid down by the Presidential Decree 25/02/2005, transposing what was established under Legislative Decree 334/1999, provide the essential elements for drawing up a plan to organise an effective response to an emergency caused by a major incident arising in a populated area. The PEE structure suggested within such guidelines clearly respects the scheme indicated in the Augustus Method, being made specific for industrial risk. As regards early warning, each industrial plant needs to have an alarm system. This is essential to make the PEE effective in terms of response to the industrial emergency. In the planning phase, the alarm system must be identified and tested so as to ascertain whether it can also be used to warn the population, in light of its area distribution (Citta’ della Scienza 2004).

With regard to pipelines breaks outside industrial plants, the Gas National Committee provides guidelines for the preparation of the emergency plans. Protocols of actions are different depending on the type of event defined respectively as first aid, gas accident, or emergency, depending on the scale. The emergency plan contains detailed instructions on the actions to perform and the officers in charge in case of different scenarios such as breaks inducing fires, gas dispersion, etc. (Aa.Vv. 2009).
6. Naples case study

Naples is one of the 5 provinces of the Campania region, which is located in Southern Italy. The entire region has 5,812,649 inhabitants and a surface of 15,081 km². Naples has almost one million inhabitants (957,012, ISTAT 2012) and a surface of 117 km². As already mentioned in the previous chapters, the risk and emergency management in Italy has a mixed top down/bottom up approach and in the following we will describe the elements that are characterising the Campania region and the Naples case study.

6.1 A multi-hazard and risk environment

Landslide and flood hazard/risk and partially vulnerability maps are available for the territory of Naples. Four levels (low, medium, medium high and very high) of hazards must be defined by law (183/1989). The landslide hazard is defined in terms of susceptibility to landslide triggering, the probability being assessed only in relative terms. Therefore each area is classified according to historical and geological/geotechnical information. With regard to floods, the hazard levels are defined as a function of the return period (T) of the event and the hydraulic depth (h). Again by law, the land is classified into four risk classes: i) low risk (R1), with marginal economic and social damage; ii) medium risk (R2), with less possible damage to buildings and infrastructures without loss of functionality and without hazard for civilians; iii) high risk (R3), with possible problems for human safety, functional damage to buildings and infrastructures with their consequent inaccessibility and interruption of socio-economic activity, damage to cultural heritage; iv) very high risk (R4), with possible losses of human lives and serious injuries, serious damage to buildings and infrastructures, damage to the cultural heritage, destruction of socio-economic activity.

The available maps have been worked out by regional and interregional Basin Authorities and are available in electronic and paper copies (scale 1:5,000 and 1:25,000). 1:25,000 maps are available online on the river basin authorities’ websites. There is not specific request by law in terms of vulnerability maps.

With regard to the warning system, the Campania Functional Centre is the only one authorized by the Department to issue weather warnings of adverse conditions in the region, including also Naples area. The centre performs the functions of meteorological surveillance and those of real-time rainfall monitoring to activate the state of alert (attention, pre-alarm and alarm). Every day, on the basis of data and output of numerical meteorological modelling, the state of the weather is analysed and forecasted, as well as the short-term forecast for Campania. At 10:30 the Regional Meteorological Bulletin is issued for the purposes of Civil Protection, with a validity of 72 hours, and transmitted to the Joint Regional Operations Room and then distributed to all 600 institutional agents making up the integrated system of civil protection in the Region (Civil Protection Department, state administrations, regions and local authorities, service and infrastructure managers, etc.).

Given particular meteorological situations, the Functional Centre assesses the daily meteorological bulletin released by the Civil Protection Department, its own regional meteorological bulletin, weighs every other relevant element and/or item of information, and issues a regional warning of adverse weather conditions (called Avviso Meteo for short), if any critical situations are forecast in the region due to the intensity and persistence of the weather phenomena expected. The Functional Centre transmits the Avviso Meteo to the Joint Regional Operations Room which then forwards it to the Civil Protection Department and to the authorities and area authorities involved. Should an Avviso Meteo be released with significant rainfall, it is followed, according to the assessment of expected soil effects on the region’s eight early warning zones, by the release, at 15:00 h at the latest, of the Critical Warning for hydrogeological and hydraulic risk. This is the tool for establishing, for each
warning zone, the critical levels (ordinary, moderate, high) corresponding to certain activation phases of the regional early warning system (attention, pre-alarm, alarm), managed and coordinated by the Operations Room with the aid of all the integrated system components of civil protection.

The critical level is established in the forecast phase and defined by assessing the rainfall precursors which are in this phase distinguished, for each alert zone, into two types: precursors of local critical levels, for rainfall events with such spatial characteristics as to affect only part of the alert zone, and precursors of diffuse critical levels, for rainfall events with such spatial characteristics as to affect the whole alert zone. For each of the precursors, three threshold values are fixed corresponding to conditions of ordinary, moderate and high critical levels. The critical level (ordinary, moderate, high) for each alert zone is established according to meteorological analysis, as well as values of rainfall precursors in each alert zone.

Naples is exposed to the seismic hazard: earthquakes of both volcanic and tectonic source can be felt in Naples. In fact, sources of seismic hazard are represented by the Apennine chain tectonic seismogenic zone and the three active volcanoes of Somma-Vesuvius, Campi Flegrei and Ischia island where there is also local seismicity, produced by shallow seismic sources, often unrelated to eruptive activity (such as the 1883 Casamicciola earthquake and the seismic crisis of 1982-84 in the Campi Flegrei).

A complete mapping of seismogenic zones and seismic classification is available at the regional level. The reference map of seismic hazard is in terms of PGA with a 10% probability to be exceeded in the next 50 years. The most recent version was issued in 2006. It has been worked out jointly by the Civil Protection Department and INGV (National Institute of Geophysics and Volcanology) and it has been validated by an international expert committee. The map is available in electronic and paper copies (scale 1:5,000) at INGV website. Data are also available with regard to seismically vulnerable public buildings (Barberi and Bosch, 1999).

Development and application of early warning systems for protection from the effects of earthquakes lies at the frontier of scientific and technological research into seismology and seismic engineering. Earthquakes may be classified as non-predictable events. In a system of seismic early warning, according to the distance from the source area of an earthquake, information on its location and magnitude may reach the site “potentially at risk” from tens of seconds to a few seconds before the arrival of seismic waves of the relevant width. The warning signal sent by the network may be used, in this case, to activate individual preventive action (at home, at work, in schools, etc.) and automatic action (shutting down or deactivating critical plants, cancelling aircraft landings, etc.). Moreover, in the phase called “near real time” (a few hundred seconds before the arrival of the destructive phase), information gathered from the seismic network may be used to construct shake maps for the area affected, so as to obtain a picture of the expected damage that may be useful to organise and implement relief.

The key element that makes an early-warning system really effective is the presence of a densely distributed seismic network above the source area of earthquakes that could affect the targets of the early warning system. So as to mitigate seismic risk in Campania, a prototype system is currently being produced to apply seismic early-warning methods, whose chief user will be the Regional Civil Protection. The structure on which the prototype is based is a high-dynamic high-density seismic network located in the Apennines (mountains in central Italy) covering an area of about 100x100 km² within which there are active faults which are the main seismic hazard sources for the region and its most populous cities.

Each Local Control Centre verifies the information received from various stations (or nodes) and transmits the location and magnitude of the event, including an estimate of the relative uncertainty.
Sources of volcanic hazard for the city of Naples are the volcanoes of Somma-Vesuvius, far from Naples about 15 km, and the volcanic field of Campi Flegrei, a wide caldera that comprises some districts of Naples. Each of these volcanoes has erupted at least once in historical times and several times in the last 4000 years.

**Vesuvius** is regarded as a very dangerous volcano due to its location in the most densely populated volcanic region in the world and the tendency towards sudden and extremely violent eruptions. The consequences of the eruption of Mount Vesuvius in 79 AD for Herculaneum and Pompei are known. After that there has been a significant eruption in 1631 which lead to between 3,000 and 4,000 casualties and destroyed parts of Portici and other towns in the area. The most recent eruption in 1944 had more limited consequences, but still destroyed several villages (OECD 2009, DPC 2011).

The **Campi Flegrei** volcanic field, localized at around 1,5 km west from Naples, constitutes a complex volcanic area dominated by the presence of a collection of calderas whose origin is attributed to the two major known eruptions, that of Ignimbrite Campana (IC, 37,000 BP) and that of Tufo Giallo Napoletano (TGN, recently re-dated to around 15,000 BP). To this volcanic district belong various craters within the caldera, which originated during the numerous eruptions that followed the TGN, the volcanic islands of Ischia and Procida and the numerous sub-marine volcanoes of the Gulf of Naples.

The eruption of 1538, the high level of seismicity of the area, the numerous episodes of heightening and subsiding of the soil, known as Brady-seism, the existence of a strong positive thermal anomaly in the subsoil of Campi Flegrei, associated high thermic gradients in the surface, and the presence of an extended field of fumaroles characterized by abundant emissions of volcanic gases in the area of the crater of Solfatara, give evidence on the fact that the Campi Flegrei is still an active volcano, and potentially a danger.

What makes volcanic risk high in the Naples area is the high density of population and property exposed to an explosive eruptive event which, in case of pyroclastic clouds, would have immense destructive power.

**Hazard and risk maps** are available in electronic and paper copies (1:5,000). One of the key risk mitigation policies consists in risk reduction in the most exposed areas. The **Action plan for Vesuvius risk mitigation** consists of wide-ranging legislation and actions aimed at progressively reducing urbanisation in the most exposed area.

Thanks to modern technologies, the Vesuvius is constantly monitored. Volcanology and the capacity to forecast eruptions have improved and permit precautionary measures such as alerts to be sounded and evacuations to be initiated though perhaps not completed. The key volcanic areas are currently monitored with modern instrumental networks by the **Vesuvius Observatory**, a division of the National Institute of Geophysics and Volcanology (INGV). Careful geophysical and geochemical monitoring may be very useful in reducing risk, since the possibility of detecting that the volcano is about to erupt allows action to be undertaken for immediate risk reduction (such as evacuating the areas most subject to hazard).

With regard to emergency planning, these two documents are available:

- an **Emergency Plan for Vesuvius**, first drawn up in 1995 by a commission of experts established by the Civil Protection Department and the Prefecture of Naples, that is periodically updated and identifies three zones with different hazardiness according to the type and intensity of phenomena expected and the related actions for the emergency management;
- a document entitled **Basic elements for national emergency planning of the Phlegrean area** defining a single level of hazardiness (red zone) identified as the area with the greatest danger of being invaded by pyroclastic flows. The complexity of the Campi Flegrei does not allow a potential eruption area to be identified, but within the red zone some areas were identified in which there is greater probability of eruptive vents opening up.

---

WP6_Task 6.3

80
The most recent version of both plans was issued in 2005 by a Committee appointed by the Civil Protection Department and is under review at present (2011).

With reference to Mt. Vesuvius, the Emergency Plan assumes that, in the next 50 years, the maximum eruptive event possible is an explosive eruption like that of 1631 (VEI=4) and identifies an area of about 1400 km² exposed to hazards that may produce damage to people and property.

The main problem for a substantive risk reduction in the Vesuvius area is the time required for evacuation: it entails an alarm at least seven days in advance, with a consequent high probability that the alarm given is “false”, i.e. not followed by an eruption, and with enormous economic and social damage and considerable problems as to the choice of when to allow the population to return. The objective is to evacuate the entire area in no more than 48 hours. Population decrease is thus only one among many other objectives to be achieved to be able to evacuate the risky areas on time, influencing the effectiveness of emergency procedures. Simulation exercises, the improvement of escape routes and residents’ preparedness are also targets to be achieved in the medium/long term.

With regard to fires a hazard map is available online (1:25000) on the website of the Department of Agriculture of Campania Region. The present map about forest fires is based on statistical, vegetation covering and climatology data (regional law 11/1996). The forest area in Naples and province covers 13841 ha. The national forest corps, the fire fighters corp, as well as the national civil protection are in charge of fire management at the local level. More precisely the civil protection is responsible exclusively for “interface” fires (inciendi da interfaccia), i.e. fires which affect urbanised and forest areas at the same time. Every year the region Campania updates his forestry plan, which includes information about Naples. Forests can be of public or private property. The municipality is in charge of the maintenance of the public forests in its territory.

Industrial risk is particularly high in East Naples, an area with a high concentration of industrial plants (including firework factories). The most worrying phenomena are major industrial accidents and those potentially caused by mobile sources, i.e. by vehicles transporting substances (hazardous raw materials or residues) including ships reaching the harbour with high quantity of oil or gas. The airport which is located in a highly urbanised area, represents also a major source of risk.

The PEE drawn up for this particular zone gives the procedures which must be followed by to manage the emergency that may impact upon people or property beyond the perimeter of individual plants inside the eastern area of Naples. The plans are prepared in order to be both full of information and advice, and clear and brief in its presentation, with a view to being proposed as an effective, concrete tool for emergency planning and management in an accident scenario which predicts the maximum event and gives the zones of definite impact, damage and attention.

In conclusion the following table reports the main authorities in charge of the key phases of the disaster cycle for the risks under study.
6.2 Risk governance profiles

As emerging from the previous chapters, the institutional architecture for the risks under study is quite complex. To achieve the key objectives of this task, i.e. identify the social and institutional barriers to effective decision-making in the case of multiple hazards, we had to reduce this complexity and to identify some key characteristics to describe and compare the governance of different hazards across different case studies.

In our view governance pertains to formal institutions empowered to enforce compliance, as well as informal arrangements that stakeholders either have agreed to or perceive to be in their interest (Renn 2008). It covers all the phases of the disaster cycle from risk pre-assessment, characterisation/evaluation, appraisal, management and communication (IRGC 2008, IRGC 2009).

We can argue that good risk governance is concerned with a set of definable qualities which enable risks to be handled in society. In this way, it is used as something to be advocated, sought after and applied. The concept has therefore at least two different dimensions, one descriptive-analytical and the other normative-prescriptive. The challenge in our research has been to define key characteristics of risk governance in order to: i) describe different profiles across countries and natural hazard types; ii) compare them; ii) identify the social and institutional barriers to effective multi risk governance.

On the basis of a literature review (De Marchi 2003, Renn 2008, IRGC 2008, IRGC 2009, Walker et al. 2010) and the first round of stakeholders’ interviews, we identified some relevant risk governance characteristics.

These characteristics cover key matter of:

- tools and plans available
- governance level and scale
- integration of available tools in planning
• balance between governance tasks and available resources
• multi-stakeholder participation
• responsibility sharing between public and private actors
• risk communication

Before describing each characteristic and how we operationalized it, we shortly describe the
general procedure we used for providing reliable evaluations. We provided a preliminary
evaluation (again on the basis of the results of our literature review and first interview round)
about these characteristic on a Likert scale from 1 (min) to 7 (max). In a second phase we
asked local stakeholders' and experts feedback about our evaluations. This feedback round
was performed with 10 stakeholders with different expertise and responsibilities for risk
management in Naples.

It is important to mention that the evaluations were provided in a numerical/quantitative form,
but they are based on qualitative judgements. Notwithstanding that, most of the evaluations
converge and, interview after interview, stakeholders tended to agree on the results
presented.

We intend these governance profiles as a dynamic rather than a static tools aimed at helping
stakeholders to identify the key barriers to effective decision making and governance.

In the following we present our results.

**Tools and plans available:** during the desk study and the fieldwork we collected a number
of information regarding the tools, plans and measures available for risk management.
Understanding what tolls and plans are available and how exhaustive they are represents a
pre-condition to allow their effective integration in multiple hazard/risk assessment and
management. We broadly classified them as follows:

• hazard, exposure and vulnerability assessment
• monitoring and warning system
• emergency plan
• risk mitigation measures

The results are shown in figure 1.9. Evaluations regard the exhaustively of the available
tools/plans/measures and are provided on a Likert scale from 1 (min: tool/plan not available)
to 7 (max: tool/plan available and covering the interested territory).
Fig. 1.9 - Evaluations about available tools and plans

* Hydro-geological risk includes floods and landslides (managed by River Basin Authorities)
**Pipeline break risk has not been included due to the lack of data available

The picture emerging from the results reflects a (science-based) system with strengths and weaknesses.

The main strengths are the hazard assessment and the monitoring/warning system. This means that for seismic, volcanic, hydrogeological and fire risk hazard maps are available and a monitoring/warning system is in place.

Exposure and vulnerability assessment is also available but with differences depending on the hazards under study. For example in the case of fire there is not a culture of vulnerability assessment and the same is partially true for hydrogeological risk. In the case of volcanic and seismic risk instead vulnerability maps are available for public buildings and also private buildings are well covered.

The main weaknesses are definitely related to emergency planning and risk mitigation measures. In the first case many interviewees report that the preparation of an emergency plan by the municipal authorities is not compulsory and for this reason the plans are not available for all the hazards. However there are deep differences. For volcanic risk there is an emergency plan prepared and constantly updated by the National Civil Protection in Roma. In the case of hydrogeological risk the responsible authorities are at the municipal level: the emergency plan was still not available when this research work has been performed. The same is true for seismic risk: in this case, as reported by several
interviewees, the key problem is the identification of escape routes, especially in some areas of the town (Quartieri spagnoli).

With regard to risk mitigation measures, the main problem is well known, and it regards the lack of economic resources from both public and private bodies. In the past few years more resources have been allocated to structural protection measures for hydrogeological risks. This is due to their higher frequency, but also to the fact that structural protection funded with public resources is more feasible than in the case of seismic or volcanic risk. Indeed in the latter case, risk mitigation measures have to be adopted at the household level and private actors, as household owners, are the main responsible for it.

As we will better comment in the following, some of the key barriers to effective multi risk governance derive or are strongly interlinked with the weaknesses described above.

**Risk governance level and scale:** to operationalize this characteristic, we used a set of qualitative indicators related to the national, regional/river basin or municipal role as well as the private sector role.

Fig. 1.10 synthesises the key results. The figure shows for example that the management of volcanic risk is highly centralised in comparison with hydro-geological risk, for which regional and river basin authorities play a key role. In the case of pipelines instead the private sector role is crucial.

As we will describe more in detail in the following (see chapt.) these results show two strong barriers to multi risk governance related to the communication between agencies working at different levels (e.g. national vs. regional) or scales (public vs. private).

![Fig. 1.10 - Role of public and private sector in governance](image)

The other risk governance characteristics (see also chapt. XX for a theoretical focused review) that we took into account are:

---

WP6_Task 6.3

85
Integration of hazard/risk assessment in planning: this characteristic relates to the integration of plans, maps and tools prepared by different authorities working at different levels in order to integrate the results of hazard/risk and vulnerability assessment in urban planning.

Balance between governance tasks and available resources: this characteristic regards the relationship between the number of tasks that different formal and informal, public and private actors have to perform in order to govern the risk and the resources available to perform them.

Culture of multi-stakeholder participation: this characteristic regards the involvement of local stakeholders in risk decision making. Stakeholder participation is a legislative requirement in the case of landslides and floods (EC Flood Directive).

Responsibility sharing between public and private actors: as a criteria we used responsibility on those at risk for protection.

Risk communication: the criteria used is the public availability of hazard and risk assessment.

Fig. 1.11 summarises the results.

Fig. 1.11 - Risk governance characteristics

The picture emerging from these results shows again a system with strengths and weaknesses, even if the latter are definitely more than the former. The main weakness seems to relate to the unbalance between governance tasks and resources. It is interesting to note that this unbalance is stronger for those risks (seismic and volcanic) characterised by a higher level of responsibility on those at risk for protection. Indeed, as mentioned already above, household mitigation measures are under the responsibility of home owners for these two geological hazards.
The culture of multi-stakeholders' participation is stronger in case of hydrogeological risks (possibly also due to the implementation of EC Flood Directive, art. 13 which gives prominence to public participation).

6.3 Benefits and barriers to effective multi-hazard/risk governance

In the following we present the results of the semi-structured interviews with local stakeholders in Naples and more precisely about their opinions on multiple hazard-risk assessment, its benefits and barriers.

Lack of an emergency plan including information about multiple hazards and risks

At present in Naples there is not a municipal emergency plan that takes into account multiple hazards/risks as well as cascade effects. There are several different plans that include a description of evacuation routes, collection points etc. for single hazards (and not even for all of them). Multi hazard or risk are not included and there is not an integrated and comprehensive emergency plan.

To justify this status quo, our interviewees provide different explanations.

First of all, “the emergency plan is not a legislative obligation for local/municipal authorities. It is recommended. This, together with the lack of resources, discourages several mayors [i.e. the authorities responsible for the emergency plan] to prepare it. Still many municipalities in Italy do not have an emergency plan and this is mostly due to the lack of human and/or economic resources, lack of political will, logistic difficulties” (Civil protection officer).

Interviewees from the fire brigades and civil protection sector report that mayors are often unprepared to take emergency decisions, even if by law they have to and tend to rely more and more on specialized corps for their decisions. According to our informants, there is a growing pressure on the services, which are expected to meet any and every demand for safety, safeguard, and security. A positive response to such demands does nothing but amplifying them, thus favouring more delegation of responsibility. The delegation of responsibility seems to be accompanied by a shifting of the blame to those whose professional remit is to take decisions and to act.

An explanation for the lack of an integrated emergency plan regards the fact that plans for different risks are under the responsibility of different authorities. For example the plan for volcanic emergency management has been prepared by the National Civil Protection (see chapt.5.3), while hydro geological emergency plans are under the responsibility of municipal authorities. The plan for hydro-geological risk is still not available (2011).

As reported by the Head of the municipal technical office: “One of the key problems for multiple emergency planning in Naples is that it is not possible to identify escape routes that can be used for different purposes. As a consequence, residents should remember different instructions depending on the risk.” As reported by the Head of one of the River basin authorities: “In case of earthquakes for example, the historical centre of the city is highly endangered and it is not possible to identify safe rescue points for the inhabitants”. Avoiding citizen panic is still a major concern for public authorities and the open communication about the lack of escape routes and safe areas worries many interviewees.

They point out that a multi hazard/risk approach would be very useful and should be implemented at the level of the regional functional centre in charge of the warning, i.e. a centre providing on time warning information for a multi risk approach.
Lack of interagency cooperation and communication and of public/private partnership

Interagency cooperation and communication may be particularly difficult for risks that are managed by authorities acting at different levels. We have already described the problems for emergency management derived by the fact that volcanic risk is managed primarily at the national level while hydrogeological risk is managed at the regional and river basin level.

In general terms, interviewees tend to agree that a decentralized system is more conductive to effective risk governance. In the case of hydrogeological risks, the risk assessment system is highly decentralized and the river basin authorities play a key connecting role between national and municipal agencies. This makes the management structure more efficient, more information and studies are available and interagency cooperation is easier in comparison with other risks. For volcanic and seismic risk instead, the high level of centralization does not seem to be conductive to more effective decision making at the local level (see also Sharma et al. 2012).

However, decentralization has also some limitations related primarily to lack of capacity at the local level, funds dedicated to disaster risk reduction often being channelled elsewhere, the fact that it does not automatically lead to more inclusive decision-making processes.

The difficulties in the communication among public agencies working at different levels is amplified in case of agencies working at different scales, and especially for public and private actors. Indeed industrial and technological risk management is mostly under the responsibilities of private industries and their assessment is often not appropriately integrated in planning handled by public authorities.

Different historical evolution of science and innovation in geological vs. meteorological hazards

Because of different professional development paths, the process of decision making – and even the language used – for geological hazards has evolved differently from meteorological or technological hazards.

For effective multi hazard and risk management it seems priority to bridge the long-lasting gap between the various hazard disciplines which is partially due to the different evolution, innovation and discoveries in science. Different methodologies and levels of uncertainty in hazard/risk assessment make comparison and integration as well as dialogue between different practitioners particularly difficult.

One of the examples often reported by the interviewees regards the monitoring and warning system. Monitoring, forecasting and hazard/risk assessment for hydrogeological risks is characterized by lower levels of uncertainty in comparison with the seismic one. The most often reported example regards the forecast of earthquakes, which is still very difficult - if not impossible -, versus floods.

Also the methodological approaches for hazard and risk assessment are very different: for example the seismic risk assessment is based on maps and on the study of the single households’ vulnerability, while the hydrogeological risk assessment is grounded on hazard and risk maps (often at a scale 1:25,000) as well as event modelling and simulations.

The deep differences in the approaches, tools and methodologies used for risk management constitute a barrier to integration also because they resulted in different practices for risk management.

Complex exchange function between regulation and governance practices

The historical evolution of science and innovation in different hazard contexts implied also the adoption of different practices and regulatory frameworks. As mentioned above the seismic risk assessment is based on maps and confronted to vulnerability assessment of single buildings, while the hydro-geological risk assessment is grounded on maps, events modelling and simulations.
As a consequence, regulation and governance practices evolved following different paths as partially shown already in the results of the risk profiles. One example is related to the different levels of responsibility attributed to private actors in geological versus meteorological risk prevention. In the case of geological risks, the level of private individual responsibility is much higher than for meteorological risks, where the risk prevention is mostly under state/national responsibility. The type of measures to be adopted is also different (in many cases structural mitigation works aimed at protecting entire communities or neighbours). Multi-stakeholder participation in decision making takes also different shapes depending on the hazard under study (see chapt.). The harmonisation of these practices is one of the key barriers to multi-risk governance.

Lack of capacity at the local level

A multi-hazard approach is mostly needed at the local (e.g. municipal) level and for this to happen local decision making has to be empowered, not only in terms of political but also financial capacities. Especially the latter represent a key vulnerability in the present risk management system. As already mentioned above another a key problem emerging during the interviews regards the high responsibility of the mayors. They are often unprepared to make emergency decisions, even if by law they have to. The regional civil protection managers lament that the mayors rely more and more on specialized corps for their decisions.

Research-practice divide

Some interviewees are sceptical about the possibilities of success for a multi-hazard and risk approach. As an example, they report on the unsuccessful integration between landslide and flood hazard/risk maps in the existing river basin plans. “The original idea for the river basin plans was to create maps covering landslides and floods by using an integrated approach. This never happened and nowadays information about landslide and flood risk assessment are hardly integrated and most of the times are presented in separate maps” (Regional Civil Protection officer).

Other interviewees mention as a key problematic issue the research/practice divide and more precisely the fact that research results are not always implemented by practitioners. “In Italy there is a huge gap between the vast scientific knowledge available and its implementation. The main objective of scientists and researchers is to publish new research results. The main objective of practitioners is to fulfil legal requirements using effective and simple methodologies. It is clear that these objectives are divergent and not always easy to reconcile” (Regional Civil Protection officer).

As revealed in this excerpt most of the times the research-practice divide is amplified by the fact that interests, objectives, needs, “languages” and priorities of these two communities are different. As a consequence, creating the conditions for an effective dialogue or exchange of knowledge and experience is considered as preliminary step for the introduction of any innovation related to multi-hazard/risk assessment.
Annex II: France and Guadeloupe

Abstract

This document gives the result of a desk study, consolidated by an inquiry addressed to main stakeholders of natural risk governance. This work focuses on the organization of natural risk governance (prevention and emergency management) for the MATRIX case study of Guadeloupe.

This work is done in order to underline existing links between hazards and analyse the efficiency of the present day system to assess if a multi-risk approach would improve the risk management.

Analysis of French organization and the focus on the Guadeloupean example underlines the top-down French organization and its benefits or barriers. It also show that Guadeloupe is susceptible to multiple hazards that can be classified as primary and secondary. Even if considered as "majors" by policy makers and scientists, secondary hazards are less studied and their prevention may be therefore insufficient.

From the desk study, it appears that a multi-risk approach guarantees an exhaustive overview of risks in a territory, and balances the culture of putting forward high intensity and/or high frequency hazardous events and missing on "secondary events". It must not exclude however to have a single risk approach for each identified hazard, whether primary or secondary, for which assessment, prevention and emergency methodology can be of different scale and nature.

Results of the inquiry comforted this desk analysis show a high risk culture of the Guadeloupean stakeholders, their strong attachment to the existing top-down organization and to the regalian function of the Prefect in risk management. Population safety and education to risk appears as a priority to all. It is considered by stakeholders that a multi-risk approach would help by bringing a holistic overview of natural risks, and bring coherency in prevention and emergency management.

Stakeholders proposition is that such multi-risk approach would be set up by the existing transversal organization, on behalf of the Prefect, and facilitated by exchange tools. It is also strongly wished that similar approaches in neighbour islands allows to enlarge risk governance to a supra regional scale, so to benefit of knowledge and experience.

Keywords: Hazard, Risk, multi-hazards single hazard, Guadeloupe, earthquake, volcanism, cyclone, ground movements, tsunami, floods, marine floods, prevention, emergency, risk management, institutions.
1. **Introduction**

Territories in Europe and associated lands are submitted to the occurrence of a wide variety of natural risks that may be concomitant or cascading in space and time. Risk prevention has been a growing concern in the last decades, but has been mostly organized to deal with each hazard separately. This induces some redundancy and overlap, if not contradiction, and therefore less efficiency in prevention.

Improving risk governance implies to improve multi-risk assessment methodology, and determine if it is significantly better (gain in efficiency -time, funding, responsibility dispatching) than dealing with single risks.

2. **French administrative structure**

French administration is organized following a top-down structuration, whether at national or local level.

The Prefect is the representative for the government in departmental or regional territories (or both) and is backed by thematic services under his authority (those thematic services are under supervision of the Prefect, but also refer to the dedicated ministries and associated central services. The Prefect is in charge of civil security for his territory in link with the ministry of interior. The state services are dealing respectively with health, education, research, environment, economy and industry, defence; they act at departmental, interdepartmental, regional or supra regional levels. The service in charge of environment is the Regional Direction for Environment, Land Planning, Equipment and Housing at the regional scale (DEAL). At the departmental level, the Departmental Direction of Territory and Sea (DDTM) is also implied in land planning and environment.

Regional administrative structures were created in 1982 by the decentralization law, gathering several departments or only one in the case of overseas territories (DROM: Départements -Régions d'Outre Mer). Departments (96 on mainland and 5 overseas) take their origin under Napoléon 1er. Regional and departmental collectivities are ruled by an elected counsell, comforted by specific administration and services.

Municipalities are the smaller administrative division. They are ruled by an elected council and a mayor designated by the council. The mayor has to guarantee the security of the commune population and seek the development of the town (which can bring up interest conflicts).

The decentralization law of 1982 and its daughter law of 2004 have given competencies to each administrative level in different fields (Table x). Some competencies are specific, other are shared and complementary.

Most of the communes have gathered or plan to gather into inter-communalities to which communes delegate some of their competencies, by a mutualisation of resources. Risk management is often one of them.
### Table 2.1 - Competencies of different administrative levels of a territory

<table>
<thead>
<tr>
<th>Main Competency in regions</th>
<th>State</th>
<th>Regional Counsel</th>
<th>Departmental Counsel</th>
<th>Municipalities or inter-municipalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land use</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roads and networks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structural equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planning/prospective</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Culture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Security</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural knowledge</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technological risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Civil security</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 3. General organization of risk management in France

**3.1 Generalities on risk management**

Risk management includes a common chain of tasks in order to prevent or reduce their happening, to manage the risk occurrence and to help recovery. Despite different structurations of the organization, this chain is almost common to all risks natural or technologic and to different countries.

Prevent or reduce risks implies assessing the risk and its components: identify the hazard (H) and its triggering forces, assess the territory exposure to this hazard, and identify the exposed assets (A) and their specific vulnerability (V) to the hazard and/or the territory vulnerability in a systemic approach.

When the occurrence of a risk can be forecasted (such as increased coastal risk in the announced changing climate), the vulnerability definition will include the adaption capacity (to adapt, cope and/or recover) (Romieu et al, 2010).

Risk assessment is accompanied by uncertainty, which is usually characterized as statistic (randomness of the natural processes) and epistemic, i.e. due to a lack of knowledge or inaccuracy of collected data.

Risk assessment is part of the preparedness to risk occurrence and the basis for information and communication plans on mitigating impact of natural hazards.

Managing risk occurrence implies to set up the capacity to answer to emergency, with a priority to population safety and protection of crucial infrastructures (road, hospitals,…) to sustain this safety. Managing risk occurrence implies also to be able to have an holistic view of possible cascade effect and induced technologic risks (fires, explosion, pollutions).
Risk occurrence also impacts economic and environmental assets during and after the crisis. Risk management therefore implies knowledge of the territory, in terms of fragility and recovery capacity of those assets.

### 3.2 French organization of risk governance

#### 3.2.1 Risk prevention

At the national level, risk prevention and risk occurrence management is within the competencies of the Ministry of Interior, with a delegation at the departmental scale to the **Prefect**; the Ministry in charge of Environment is in charge of developing knowledge on risks and developing prevention and mitigation tools.

At the departmental level, the Prefect is, as said above, in charge of civil security and is therefore the coordinator of all aspects of risk management (either prevention or crisis management).

Regional and departmental collectivities, as well as some inter-communalities collaborate to risk prevention, when assets in their responsibility (schools by example) are exposed to hazard and as part of their environment and land use competency. They are more specifically involved in sustaining risk knowledge and awareness.

The mayor is in charge of the civil security within the limit of his commune. This implies information on known potential risks, prevention measures and emergency actions in case of risk occurrence. He refers of his actions to the Prefect, who may act as a subsidiary if the mayor fails in his function. In case of risk occurrence, he is kept informed by the Prefect, and organizes emergency actions in his territory.

Research on natural risk is promoted at different levels: at national level, it is targeted to answer and sustain needs in making policy and developing methodologies and guides (Ministry in charge of environment-MEDDE). At local level, it aims answering specific problems, with funds from collectivities, state and/or Europe (CPER, FEDER, ...).

Several public organisms are involved in research and help in policy making, such as BRGM, INERIS, IRSTEA (ex CEMAGREF), CEA, IRSN, METEO France, CNRM, CIRED, as well as specific university laboratories such as IGBP, Clermont university, UAJ, which are specialized on different single hazards and risks. Public institutes also have state missions on specific risks, in an objective of complementarity and synergy but, in cases, overlap of responsibility; this will be the object of discussion further in the document.

Some public institutes, as seen further, are in charge of monitoring hazards than can be forecasted, and sustain the Prefect function to give alert, in case of risk occurrence (Météofrance, IPGP-OVSG, ...). They also act as experts, (MétéoFrance, BRGM, ...) after risks occurrence, to confirm that observed damages have a natural triggering (constats de catastrophe naturelle).

Policy makers rely on transfer of research to help producing policy documents that are “opposable” to any land planning document and are used to inform at different levels and help decision for prevention actions (DDRM, DCS, DICRIM).

Producing these DDRM and DCS documents is coordinated by the departmental Prefect or a delegated state service. The town mayor produces the DICRIM.

These documents follow guidelines designed by the ministries for interior and for environment, with the help of scientists and experts.

The DDRM compiles known risks within the department under the Prefect or delegate coordination, which are state services in the department (equipment, environment, health, security, communication) and the help of experts and scientists, which are public or private
agencies whose knowledge or expertise may confirm the risk management or crisis management policies (MétéoFrance, BRGM, ONF, ....).

The DDRM covers all risks (natural, technological, transport and conflict) classified as "major" in the studied territory ("major" implies human, economic or environmental assets exposed). Some risks may be considered as negligible on those assets and might not be described in the document. Each risk is described by its processes, typology and driving forces and a simplified hazard map is drawn. Existing policies for the risk are recalled; advices on behaviour of population, before, during and after the risk occurrence, are given. Agencies in charge of information are quoted. Apart from a presentation that may follow the highest to lowest probability of occurrence or intensity of hazards, no interaction is proposed in most departments for a multi-hazard approach of either prevention management or crisis.

DCS (Documents Communaux Synthétiques) are the declination of the DDRM at the municipality scale; known risk are listed and described within the town territory, without considering interactions. This document is written by the Prefect security services and addresses the mayor who is in charge of informing the population of known risk.

The mayor transfers this information to the population through a DICRIM (Document d'Information Communale sur les Risques Majeurs) providing information on known risks, existing or planned measures for prevention, protection and emergency.

More specific planning documents have been developed in some departments to prepare vulnerable population to specific crisis (such as family-PFMS- and schools populations-PPMS-in case of seismic hazard in Guadeloupe)

Answering to the mayor demand, the Prefect prescribe the elaboration of risk prevention plans (PPR), which are elaborated for single risks or multiple risks at town scale. PPR designs servitude of public utility, “opposable” to any other planning documents and are to be included in urban document such as SCOT, PLU/POS and municipal mapping. PPR usually leads to protection measures, recommendations and development constraints (e.g. no development, development under regulations, insurances limitations) in order to reduce the hazard or the asset exposure. Once elaborated by an association of expert scientists and policy makers, PPR are submitted to public advice and finally approved by the Prefect and applied. PPR and DICRIM are in free access to the citizen, within the town hall, and are to be considered when the town delivers any authorization for public or private building. The Bachelot Law of 2003 also impose to the seller in any dwelling transaction to inform on known exposure of the dwelling to any natural or technological risk

However, population is little aware of risks and do not often refer to those documents despite their public accessibility.

3.2.2 Risk occurrence management. Feedback to risk prevention

Unless the risk is at national scale, emergency actions are then under the Prefect responsibility and competent authorities such as designed by the Prefect: alert the public, manage the administration of the crisis and ensure post crisis recovery measures.

The Prefect works with other services such as the regional directorate of environment, spatial planning and housing (DREAL), the regional director of public finances, the prosecutor, NGOs and approved associations of civil safety (ADPC, Civil Protection, Red Cross, etc..)

The management of relief operations (DOS) is under the responsibility of the Prefect of the concerned department. The Prefect is advised by the commander of rescue operations (COS) who is a fire fighter officer (Error! Reference source not found.). For this mission he is also assisted by the Departmental operational centre (COD) based in the Prefecture Its composition is necessarily multi-services and adapted to the nature of the event. If
necessary, one or several Operational headquarters (PCO) located close to the disaster and depending on a sub-Prefect. It is not always activated.

At national scale, the C.O.G.I.C is responsible for preventing major risks and organizes relief in case of very serious disaster. The C.O.Z has the same functions than the COGIC, at the “zone” level (supra-regional).

Fig. 2.1: Organization of emergency at different level of decision

The Prefect (or the Prime minister, if the risk occurrence is at national level) can decide of the application of an ORSEC plan. The ORSEC plan is a general plan describing the emergency organization in case of disaster, when the local means are not sufficient and defines the actions needed to restore a normal situation.

The ORSEC plan in its latest version urges the municipalities to design a Safety plan (Plan communal de Sauvegarde, PCS), in order to be prepared to the risks occurrence, and have the means to act in emergency (information of citizen, evacuation, etc…). This PCS must consider all possible risks, (natural, social or technologic) and should consider their possible concomitance.

As soon as possible, after the risk occurrence, damage observation statements ("CATNAT") are made to validate the status of “natural event” and support the settling of compensation by insurance companies. Specific compensation funds are requested, depending on the hazards, and are funded either by insurance companies or by a common fund created by law (Fond Barnier, 1995). This fund is held by re-insurance companies, and is made of state funding and levy on individual insurance policies. A decreasing rate of compensation to insurance policy holders is applied; if no measures are taken to reduce or prevent the risk in the commune, such rule is made to trigger the mayors in asking the Prefect for setting up prevention plans (PPRN).
4. Background for Guadeloupe

4.1 The context

4.1.1 Administrative context

Guadeloupe archipelago (Fig. 2.2) is one of the 5 overseas French territories (Département-Région d'Outre Mer) located in the West Indies. It is under French national and local administration system with the specificity of having both regional and departmental collectivities within the same territory.

Guadeloupe gathers 5 main islands: Grande-Terre, Basse-Terre, Marie-Galante, la Désirade and Les Saintes. It represents an area of 1,628 km² and 32 municipalities.

Within the Prefecture, the SIDPC (Service Interministériel de Défense et de Protection Civile) is in direct link with the Prefect. The state local service in charge of environment and land use is the DEAL (Direction de l’Environnement, de l’Aménagement et du Logement)

Saint-Barthélemy and Saint-Martin have the status for Overseas Collectivities and have their own organization. Whether part of the French overseas territories, they have an autonomous situation in regard to social welfare, and taxes. They have a deputy, representative at the French parliament, but French law will only apply to the collectivities if specified. Those collectivities deal on their own for risk management, since their creation in 2003.

Fig. 2.2 - Map of the Guadeloupe archipelago

4.1.2 Geophysical context

Guadeloupe is prone to volcanism and seismic activity due to its position on the Caribbean arc, due to the subduction of the north and South American tectonic plate under the Caribbean plate. Basse-Terre (848 km²) and Les Saintes are mostly recent volcanic rocks (Fig. 2.3). Their mountainous configuration is dominated by the active pelean volcano of la Soufrière (1467m asl).
The hilly landforms ("mornes" and "ravines") of Grande-Terre, Marie-Galante and Petite Terre are made of Pleistocene reef limestone, overlying an older pre-Miocene volcanic substrate.

La Desirade Island is a tilted limestone plateau, of lower Pliocene age, overlying Upper Jurassic or Lower Cretaceous igneous rocks.

Grande-Terre and Basse-Terre on the main island are separated by a natural narrow salted channel, called "Rivière Salée" edged by a mangrove system. Most of the coast is made of cliffs and narrow beaches, often protected by a coral reef and associated lagoon.

Fig. 2.3 - Representation of the subduction system of the lesser Antilles

4.1.3 Meteorological context

Guadeloupe is ruled by a tropical climate, with a wet season from May to November, and a dry season from December to March. The dominant wind is the “alizé” blowing NE to SW from the tropical line towards Equator. During the wet season, Guadeloupe is frequently hit by cyclones (also called hurricanes). Its situation on the tropical zone of Cancer lead to a high precipitation range Guadeloupe during the wet season and a non-negligible rainfall in the other periods, allowing a rich and biodiverse tropical vegetation.

4.1.4 Land use and economy

Guadeloupe population reaches around 400 000 inhabitants.

The main urban zone of Guadeloupe is the agglomeration of Pointe à Pitre, spread on a wider plain on both parts of the Rivière Salée. Most of other cities are concentrated on a narrow coastal zone, around Basse-Terre, and more disseminated on the coast and inland in Grande-Terre, and the other islands. The centre of Basse-Terre is densely vegetated by tropical vegetation.

Guadeloupe economy is relying on agriculture (bananas, sugar cane and tropical fruits), mostly located on hills and high plains, which supports some agro-alimentary industry (sugar, rum) and exportation (fruits). Most of the industrial and commercial activity is gathered in the Jarry zone, east of Point-à-Pitre, apart from some main rum distilleries implanted on the coastline of Basse-Terre.

However, Guadeloupe economy is showing a deficit linked to high prices of living goods (largely imported from mainland France) and high unemployment.
4.2 **Hazards under study**

Natural hazards in Guadeloupe can be described as geologic hazards and meteorological hazards, if referring to the triggering forces. Most hazards are interrelated, one hazard being the triggering force for a "secondary" hazard. Some hazards might have multiple possible drivers, more specifically landslides that can have both geological and meteorological triggering forces.

4.2.1 **Geological hazards**

Geology of Guadeloupe infers major risk linked to its active volcano and seismic activity along the inner Caribbean arc. Tsunamis and landslides can be induced by those hazards. Recently also, a tsunami happened on the eastern coast of Basse-Terre (Deshaies) triggered by an underwater landslide in Montserrat, itself induced by the volcanic activity of the Soufrière of Montserrat.

4.2.2 **Meteorological hazards**

The major meteorological hazard in Guadeloupe is its cyclonic (hurricane) activity, having a direct impact through very high winds (up to 200 Km/h) and secondary effects by inducing (i) a sea water surge and marine floods and waves that can erode the coastal zone and (ii) heavy rainfall that can lead to inland floods and landslides.

4.2.3 **Relationships between hazards**

The Fig. 2.4 draws the different natural risk to be considered in Guadeloupe and the relationship between them, in terms of triggering forces and hazards. It is to be underlined that landslides have either meteorological or geological triggering forces.

Fig. 2.4 - Relationships between different hazards (arrows orientated in the sense of triggering)
4.3 Risk prevention

All the hazards quoted in this figure, except tsunami, only quoted as an associated risk to earthquakes, are also considered in the Guadeloupe DDRM (2004, being currently updated, declined in DCS.

Multi-hazard prevention plans have been elaborated and are applied in all Guadeloupean municipalities, and appended to urban documents whether PLU or POS. However, as said by interviewed stakeholders at different level (municipalities, DEAL, SIDPC) this approach is more a compilation of individual prevention plan where each hazard individually. If the hazard is known to trigger a secondary hazard, it might be considered within the primary risk plan (cyclones and marine surges) or is just quoted in the PPR and dealt with at a separated level (earthquake and landslide).

Fig. 2.5 - Situation of natural risks prevention plans in Guadeloupe

As a French Department, Guadeloupe archipelago has the same organization as any other. Research and policy supporting actions are implying the Volcano and seism observatory (IPGP/OVSG), local universities and the different public agencies having a local representation (BRGM, MétéoFrance,...).

The table 2.2 presents the distribution of actions in risk knowledge, prevention monitoring and alert between public institutes and state representatives in the department of Guadeloupe.
Tab. 2.2 – Authorities in charge of the different disaster cycle phases in Guadeloupe

<table>
<thead>
<tr>
<th>Driver</th>
<th>Hazard</th>
<th>Hazard assessment</th>
<th>Prevention/ preparedness</th>
<th>Monitoring</th>
<th>Advise on Alert</th>
<th>Alert</th>
<th>Crisis management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyclone, tropical storm</td>
<td>Cyclone, tropical storm</td>
<td>MétéoFrance</td>
<td>MeteoFrance (NOAA/NHS)</td>
<td>MétéoFrance</td>
<td>DEAL/BRGM, Municipalities (DICRIM)</td>
<td>Mayors and application of PCS</td>
<td></td>
</tr>
<tr>
<td>Wind</td>
<td>Wind</td>
<td>DEAL/BRGM, Municipalities (DICRIM)</td>
<td>MeteoFrance</td>
<td>MétéoFrance</td>
<td>Mayors and application of PCS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy Rainfall</td>
<td>Heavy Rainfall</td>
<td>DEAL/BRGM, Municipalities (DICRIM)</td>
<td>MeteoFrance</td>
<td>MétéoFrance</td>
<td>Mayors and application of PCS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy rainfall</td>
<td>Inland flood</td>
<td>DEAL/BRGM, Municipalities (DICRIM)</td>
<td>MeteoFrance</td>
<td>MétéoFrance</td>
<td>Mayors and application of PCS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storm surge</td>
<td>Marine inundation</td>
<td>Météofrance/ BRGM</td>
<td>MeteoFrance</td>
<td>MétéoFrance</td>
<td>Mayors and application of PCS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waves</td>
<td>Erosion</td>
<td>Météofrance/ BRGM</td>
<td>MeteoFrance</td>
<td>MétéoFrance</td>
<td>Mayors and application of PCS</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volcanism</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy rainfall, earthquake, volcanism</td>
<td>Ground movement</td>
<td>BRGM</td>
<td>OVSG</td>
<td>OVSG</td>
<td>Mayors and application of PCS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volcanism, earthquake, landslide</td>
<td>Tsunami</td>
<td>OVSG/Univ/ BRGM</td>
<td>OVSG/SHOM</td>
<td>OVSG</td>
<td>Mayors and application of PCS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earthquake</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

WP6_Task 6.3

100
### 4.4 Crisis management

Table 2.3 extracted from the DDRM (2004) of Guadeloupe, shows the top-down organization of emergency, around a fixed cell of commandment (Poste de commandement fixe-PCF), as designed for a cyclonic event where MeteoFrance is in charge of indicating the alert level to the Prefect, who decide of declaring this level to the population, through each municipality mayor, and with the requisition of medias. In case of an earthquake, a volcanic eruption and/or a tsunami the OVSG is in charge of indicating the alert level to the Prefect.

This organization follows the general rules of emergency as described above for crisis management in France. Besides, different emergency plans are ready for Guadeloupe: ORSEC departemental plan, and its communal declination, PCS, (currently ready for 12 on 32 municipalities), emergency plans in case of human victims, peculiar plan for the industrial zone of Jarry, and economic defence plans. Specific safety and rescue plans are ready in case of occurrence of cyclones (Plan ORSEC Cyclones, 2004)), earthquakes (Plan de secours spécialisé Seismes, 1998) and volcanic eruption (Plan de Secours spécialisé Volcan, 1999).

Tab. 2.3 - Organization of crisis management in Guadeloupe (DDRM Guadeloupe, 2004)

### 4.5 Single risk characterization and present day risk governance

This chapter mainly presents information on risk prevention management, knowing as described above that emergency is coordinated, whatever is the hazard, by the prefectural organization, being the state representative, as shown on Tab.2.2 and if a national ORSEC plan is needed, by the ministry of Interior.
4.5.1 Earthquakes

Hazard

The Guadeloupe Island belongs to the Lesser Antilles arc. This arc, in the eastern Caribbean, is prone to a strong seismic hazard, whose trigger is the subduction of the Atlantic lithosphere beneath the Caribbean plate, with a slow convergence rate of 2 cm/year (figure 2). Guadeloupe is located in a seismic V zone, the most important for the national territory. Earthquakes as the event of 1839 and 1843 would cause the depth of thousand people.

Due to this tectonic context, several types of earthquakes are distinguished among the recording of different regional events: shallow crustal earthquakes and subduction earthquakes.

The first types occur in the Caribbean plate at a depth between 0 and 50 km (mostly between 0 and 30 km). These shallow crustal earthquakes present a mechanism of normal fault (context of extension) and are predominant in the regional seismicity. The earthquake of Les Saintes (2004) is an example of this type of seismicity.

Subduction earthquakes are

- Events occurring at the interface between Caribbean and Atlantic tectonic plate at shallow depths (epicenters <50 km) with a mechanism of inverse fault (context of compression). The 1843 earthquake is known to have been an interface event.

- Intraslab events occurring in the portion of the Atlantic plate which is already buried. Epicenters are localized between 50 to 200 km deep and the mechanism is due to normal fault. The earthquake of November 29th 2007, magnitude 7.4 situated of north of Martinique island is an example of this type.

According to the national seismic hazard mapping and its classification in five classes of national territory, Guadeloupe is located in zone V (higher hazard). Historical events are known to have reached an intensity of VII (1851) to IX (1843) The latest destructive earthquake, in Les Saintes in 2004, had a magnitude 6.3.

Secondary effects of earthquakes are the propagation of the initial movement to the surface, as well as triggering ground movement of unstable soils and liquefaction of little cohesive or water saturated soils (sands, silts, ooze).

Assets at stake

The largest historic earthquake of 1843, caused thousands of deaths. The latest 2004 event caused major damages in housing and the death of a child.

All the archipelago population and economy is exposed to this hazard.

Combination of the seismicity, population and urbanization density as well as intrinsic vulnerability of buildings, susceptible to collapse, results in a high seismic risk for most of the territory of Guadeloupe.

Monitoring

In regard to monitoring and warning, earthquakes are abrupt phenomenon, impossible to forecast with nowadays level of knowledge. This sudden character increases the vulnerability of population and could have heavy consequences on infrastructures, economic and social balance.

The Volcanic and seismologic observatory of Guadeloupe (OVSG), part of the Globe physics Institute of Paris, is the institute in charge to the seismic monitoring. Its function is to rapidly inform the public authority as soon as an earthquake occurs, by specifying the characteristics of the event (localization, depth, magnitude and predicted intensity).
The OVSG guarantees the recording of the regional tectonic seismicity supported by a seismic network spread on the whole Guadeloupe archipelago. The data are acquired in real time by a permanent recording system.

A regional seismic network of about 20 stations (seismometers and accelerometers) is deployed in the Guadeloupe archipelago as well as on Antigua, Montserrat and Dominica islands. This network is integrated with other regional seismic networks, principally in Martinique, but also in Trinidad (Seismic Research Centre), Montserrat and Puerto Rico. Every year, it records 1 500-2 000 regional and local earthquakes, of which about 5 per year are felt by the population in Guadeloupe.

Risk mitigation (prevention and reduction) and crisis management

Most of the existing buildings and public works in Guadeloupe are not adequately protected against the consequence of earthquakes. One way to take into account this risk induced by the assets at stake in a local scale is the seismic microzoning; this type of study allows knowing the seismic response of the soil to identify the potential zone of site effect.

In regard to risk mitigation, the focus of most of the legislation has been to improve building code provisions, the major cause of injury and death in earthquakes being the failure of buildings; the goal is to build structures to answer current engineering practice according to the rules of the art. The national seismic hazard mapping makes compulsory the application of the seismic code (according with the European EC8 code) for new constructions and rehabilities.

The “Plan Séisme Antilles” is a national project of seismic risk prevention. This plan relies on an inter-ministerial central unit piloted by the Ministry of Ecology. At a local scale, this plan is managed by the Prefect who chairs the “comité - séisme” and delegated to the DEAL. This plan implements studies to reduce the vulnerability of the existing stakes (diagnoses, rehabilitation, and reconstruction) and studies to improve the knowledge of the seismic hazard and its consideration in urbanization. Education to the risk, information, formation to mitigate the seismic risk, are also objectives of the plan (Fig. ).

Fig. 2.6 - Sticker given out to the population during a “information week “on seismic risk in 2012
As said before, the crisis management is taken in charge by the civil security services, under the responsibility and coordination of the Prefect, following the above described rules, and transferred to the mayors of each municipality, in charge of guaranteeing the security of the municipality population. In case of failure of the mayor, the Prefect will act as subsidiary.

**Barriers, lacks and forces of the existing system, for seismic risk**

A said above, prevention plans draw building restrictions on new developments. Any new building has to be designed and built following the French seismic code. Private buildings have to follow this code, even for individual housing (a sort of simplified seismic code called CP-MI). In reality, vulnerability assessment studies show that a big number of the existing (even recent) buildings do not follow the rule and are vulnerable. This is partially taken into account in the recent "Plan séismes", by rehabilitation of public dwellings and in planning of urbanization.

Considering other major risks in the archipelago, the likely occurrence of cyclones in Guadeloupe has encouraged building heavy concrete 1st floors or roofs. Those are counter-efficient, in case of earthquakes: collapse of concrete slabs have caused of many deaths in Haiti in 2010, and are an example of contradictory recommendations made when dealing with a single risk.

A strong action of information has been recently sustained in the frame of “Plan Seisme”, aiming to raise seismic risk consciousness of the population and give advice on behaviour in case of seism occurrence. It appears, in its first results, efficient on the scholar population, and in return on their parents.

As described, seismic activity is also a driver for secondary risks. Most hazard studies are orientated on the direct consequences of earthquake, due to its higher damaging impact on human life and economy. Cascade secondary risks such as site effect and liquefaction, as well as concomitant possible triggering of landslides by seism and rain saturated soils are quoted in the different prevention documents and are also considered in the microzoning in process in Guadeloupe. However the result of those recent studies are not yet considered in Guadeloupe seismic PPR..

### 4.5.2 Tsunami Hazard

Tsunami is a train of ocean waves caused by a major scale and violent mechanical action. It can be the result of a tectonic event, a volcanic event, a landslide or even a meteorite crash.

However, tsunamis are mostly triggered by seismic or volcanic events. The seismic sources can be close or distant, whereas the volcanic sources are close. Guadeloupe is also under the influence of other islands’ volcanoes, such as, recently, Soufrière-Hills, volcano of Montserrat.

Pedreros and al (2007) were able to identify several seismic sources in particular the normal Fault of Marie-Galante and the inverse fault of the accretion prism of Barbuda.

Two types of volcanic sources are identified: (i) Entrance of the volcanic material in the sea during eruptions (such as the event of Montserrat in July 2003, impacting the western coast of Basse Terre), (ii) Destabilization of a part of the volcano and collapse in the sea.

Several earthquakes located in Jamaica and Haiti generated tsunamis which reached the coasts of Guadeloupe (Zahibo and Polyakovski, 2001; Lander and al., 2002).

In July 2003, a very important collapse of the volcanic dome of Soufriere Hills of Montserrat (the most important collapse of volcanic dome known) caused tsunami which affected the Guadeloupe island, mainly on the west coast of Basse-Terre (Pelinovsky et al., 2004).
Tsunami mostly exposed the coastal zone and plains, in a range depending on the waves range, and intensity of the triggering event. The consequent submersion is sudden and violent and would affect human life and dwelling, and in consequence, economy.

**Monitoring**

A Caribbean alarm system was settled in 2005 by IPGP and BRGM. The OVSG has installed 2 maregraphs for observation.

Within the framework of the alert tsunami network for the Caribe, the networks of seismic survey in the arc of the Lesser Antilles are in full restructuration since 2005. New broad-band stations are installed, with, for some of them, a real-time transmission using satellite.

In Guadeloupe, 2 broad-band stations were installed by the OVSG in 2008 (Deshaies and Desirade) outings by broad-band seismometer, accelerometer, GPS and satellite transmission. Six stations of the same type are planned in the years to come.

**Risk mitigation**

If studies were committed to create an alarm system of the population in case of tsunami (Auclair and Bertil, 2008), nothing is still implemented. Furthermore, awareness-raising activities of the populations, formations of the teachers and the pupils would be necessary, in particular in the littoral zones subjected to the local tsunamis.

A case study was driven by the BRGM for the Ecology minister: simulations for different scenarios were led to illustrate the potential impact of tsunamis about the coasts of Guadeloupe.

Posters were recently disseminated in coastal municipalities (i.e., most of Guadeloupe municipality) to advice on behavior to have in case of tsunami. These take into account the possible triggering effect of earthquakes, as a first sign of possible occurrence of tsunami.

**Barriers, lacks and forces of the existing system for tsunamis**

Despite above described actions, consciousness of the tsunami risk is still low and does not appear to the population nor the deciders as major and a priority. It would need further studies, and information and education at different levels.

**4.5.3 Volcanic hazard**

**Hazard**

The volcanic island of Basse-Terre, which is part of Guadeloupe, consists of 7 main eruptive fields, each composed of several volcanic centres. Only the Soufrière is an active volcano, formed 200,000 years ago.

The last magmatic eruption occurred about 560 years ago, and was a complex eruption with many similarities with the on-going Montserrat Soufrière eruption. This 1450 eruption culminated by the formation of the current Soufrière dome. All historical hydrothermal activity and the six phreatic explosive eruptions of 1690, 1797-98, 1812, 1836-37, 1956 and 1976-77 AD have taken place from fractures and vents on this dome. La Soufrière of Guadeloupe, located within the Parc National de la Guadeloupe and just 5 km North-East of the town of Saint-Claude (population 10 000 inhabitants) is a well-monitored active volcano. In the last decade, the Volcano Observatory has recorded systematic progressive increase in shallow low-energy seismicity, a slow rise of temperatures of some acid-sulphate thermal springs closest to the dome, and noticeably, a significant increase in summit fumarole activity associated with HCL-rich and H2S acid gas emanations. Permanent acid degassing from two summit high-pressure fumaroles is observed. This degassing has caused vegetation damage on the downwind flanks of the dome and required closure to the public of parts of the most active areas since 1999. No other anomalous geophysical signals have been recorded.
Apart from most likely phreatic eruptions, dome eruption generating pyroclastic flows (7 in the last 15,000 years) and partial edifice-collapses generating debris avalanches and blasts (10 in the last 15,000 years) would represent a major eruptive event, most likely to occur in the future from the Soufrière dome area. The region and nearby islands would also be affected by tsunamis and ash clouds, that induce a hazard to civil aviation.

Moreover, eruptions could be activated more rapidly by a regional earthquake. The earthquake of Les Saintes caused ground movements in the Soufrière dome.

Table 2.4 summarizes the different possible volcanic events, their probability of occurrence and hazard zones in case of volcanic events.

Tab. 2.4 – Volcanic events, probability of occurrence and hazard zones

<table>
<thead>
<tr>
<th>Volcanic Event</th>
<th>Color</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paroxismal eruption</td>
<td>Brown</td>
<td>Volcano areas where a sectorial collapse can occur because of geological structure and mechanic characteristics.</td>
</tr>
<tr>
<td></td>
<td>Yellow</td>
<td>Areas where there is a risk to see fragment avalanches. During the eruption a little tsunami can occur due to the entrance of the volcanic material in the see.</td>
</tr>
<tr>
<td></td>
<td>Purple</td>
<td>Areas exposed to the blast from the eruption and the explosion products.</td>
</tr>
<tr>
<td></td>
<td>Green</td>
<td>Areas affected by ash.</td>
</tr>
<tr>
<td>Magmatic eruption</td>
<td>Brown</td>
<td>Area which could be under lava flows, glowing lava or crude pumice deposits, under glowing clouds more or less cover with explosive projections.</td>
</tr>
<tr>
<td></td>
<td>Blue</td>
<td>Area exposed to the blast and lava projections associated with glowing clouds</td>
</tr>
<tr>
<td></td>
<td>Green</td>
<td>Area affected by mudslide downstream from Grand-Etang</td>
</tr>
</tbody>
</table>
**Phreatic eruption**
- **Red:** block projections within a 2 km radius around the emission point
- **Yellow:** block projections within a 4 km radius and a most important volume of material
- **Purple:** mudslides come out of the valleys
- **Green:** fragment avalanche in the case of a partial destabilization
- **Blue:** fragment avalanche in the case of a total destabilization of the dome

---

**Tab. 2.5 : Different possible volcanic events for the Soufrière of Guadeloupe**

<table>
<thead>
<tr>
<th>Type</th>
<th>Eruption</th>
<th>Description</th>
<th>Estimated recurrence</th>
<th>Cities implicated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phreatic</td>
<td>Phreatic only</td>
<td></td>
<td>20 to 50 years</td>
<td>Baillif, Saint-Claude, Basse-Terre, Gourbeyre, Trois-Rivières, Capesterre-Belle-Eau</td>
</tr>
<tr>
<td>Magmatic</td>
<td>Eruption with creation of a viscous lava dome</td>
<td>With or without pyroclastic flow</td>
<td>500 to 1 000 years</td>
<td>Vieux-Fort, Goyave, Vieux-Habitants</td>
</tr>
<tr>
<td>Sectorial collapse</td>
<td>Eruption and a side of the mountain collapse</td>
<td>With fragment avalanche</td>
<td>2 000 to 5 000 years</td>
<td>Vieux-Habitants, Baillif, Basse-Terre, Saint-Claude, Gourbeyre</td>
</tr>
<tr>
<td>Magmatic</td>
<td>Explosive eruption</td>
<td>Cone of scories are formed</td>
<td>5 000 to 10 000 years</td>
<td>Vieux-Habitants, Baillif, Saint-Claude, Gourbeyre, Trois-Rivières, Capesterre-Belle-Eau, Goyave</td>
</tr>
<tr>
<td>Magmatic</td>
<td>Effusive eruption</td>
<td>Lava flows</td>
<td>10 000 to 20 000 years</td>
<td>Saint-Claude, Baillif, Basse-Terre, Trois-Rivières</td>
</tr>
<tr>
<td>Type</td>
<td>Description</td>
<td>Duration</td>
<td>Locations</td>
<td></td>
</tr>
<tr>
<td>-----------------</td>
<td>------------------------------------------------------------------------------</td>
<td>---------------------</td>
<td>------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Magmatic</td>
<td>Catastrophic Plinian eruption with explosive magma emission (pumice and pyroclastic flow)</td>
<td>50,000 to 100,000 years</td>
<td>Vieux-Habitants, Bailif, Saint-Claude, Gourbeyre, Basse-Terre, Trois-Rivières, Vieux-Fort, Capesterre-Belle-Eau, Goyave</td>
<td></td>
</tr>
</tbody>
</table>
If the risk associated to volcanism is itself very high, it is to be recalled that secondary hazards can be triggered by an eruption such as ground movements (landslides, rock falls). Those secondary events are increased by the high weathering capacity of the soil due to its volcanic nature combined with a humid-tropical climate. Those “secondary” hazards are discussed in the “ground movement” (paragraph 2.5)

**Assets**

A major event of dome eruption would directly threaten about 72,000 people, cause widespread destruction to most of southern Basse-Terre (table X), and require a total evacuation.

Phreatic eruption could engender significant and recurrent nuisances and risks to the population largely due to frequently and strongly felt volcanic seismicity, the contamination of the atmosphere by acid gases and fine corrosive volcanic dust, the contamination of spring waters from the volcano used as the main source of potable water. The acid corrosive atmosphere could damage telephone switch lines, corrode water distribution pipes and cause numerous nuisances.

The 1976-1977 phreatic eruption instigated the evacuation of about 70,000 people from a large area, for 4 to 6 months, and engendered severe socio-economic difficulties for the population in southern Basse-Terre as well as for the remainder of Guadeloupe, having a profound and prolonged influence on society, continuing long after the crisis had subsided.

The main environmental indirect effects common to all eruptive scenarios (intense prolonged fumarolic activity, phreatic eruption, edifice collapse eruption, effusive and explosive dome-forming eruption, large explosive eruption) are long-term emissions of gases (SO2, HCL, HF, H2S) which are likely to cause some indirect nuisances to crops, cattle, disturbances to the population or even infrastructure because of the highly corrosive properties of the acid condensates and acid rainfall. The extend of the nuisances will depend on many factors including the gas chemistry and flux, the number of vents and their location, meteorological factors and the duration of the crisis. Agricultural crops and animals feeds are likely to be contaminated to varying degrees downwind of the volcano and up to a distance of a few kilometres. The springs, including those used for bottle water, streams and water collection tanks that are used for water consumption in Guadeloupe could be affected. Roofs made of corrugated metal sheets could be corroded by acid rains and thus contaminate running water. Persistent exposure to low concentration SO2, H2S and HCl aerosols as well as hazardous mineral dusts may cause health problems in the local population.

Recent improvement of knowledge of volcanic hazard however underlines the fact that:

- Potential future reactivation of La Soufrière volcano of Guadeloupe will pose significant hazards and risks for the 73,000 people which reside within 15 km of the volcano in southern Basse-Terre Island. They represent 17% of the population of the entire Guadeloupe region including nearby island dependencies and up to 20% of the Guadeloupe mainland population excluding all dependencies. Moreover, the indirect consequences of a Montserrat-like eruption would be significant for the remainder of Guadeloupe as well as for nearby islands.

- Phreatic eruptions are the most frequent and most probable on Soufrière volcano. The next most frequent eruptions in the last 15,000 years were the highly damaging edifice collapse events, which can actually occur in all scenarios including a major phreatic eruption, without involvement of magma. This scenario is most likely for the populations of Saint-Claude, Basse-Terre, Gourbeyre and Trois-Rivières; for a total estimated population of about 39,000 and up to about 58,600, if collapse would affect not only the SW but the SE flanks of the volcano. This area does not include population that could be affected by tsunamis triggered by debris-avalanches entering the sea; such events could affect the coastline of southern Basse-Terre and nearby islands. Probable dome eruptions such as the 1440 Ad eruption of La Soufrière de
Guadeloupe or an eruption similar to the Soufrière Hills in Montserrat, will also directly or indirectly threaten most of the southern part of Basse-Terre Island.

Monitoring

The Volcanic and Seismologic Observatory of Guadeloupe (OVSG), which depends of the Globe physics Institute of Paris, is the institute in charge to the monitoring and watch of the volcanic activity supported by a permanent network. This instrumental network will detect forerunners of an eruption: volcanic seismicity, volcano deformation, physical and chemical gas parameters, thermal sources. The current network includes about 70 remote-controlled permanent stations with continuous or semi-continuous recording about 250 sites measured manually in the field with varying periodicities. Short period and broad-band sensors record volcanic seismicity (hypocentres, magnitudes and type): volcanic event due to magmatic sources and shallow events related to hydrothermal activity. Volcano ground deformation is monitored on different scales and sensitivities with tiltmeters, GPS permanent stations and repetition network (3-D displacements), laser-based distance measurements and extensometry on historically active fractures on the dome. Fluid circulation is monitored using physic-chemical analysis of thermo-mineral springs and fumaroles (temperature, flux, pH, conductivity and complete chemical analysis), microgravity surveys, ground self-potential measurements, magnetic field permanent stations, multi-parameter physical sensors, etc. … This comprehensive network is complemented with systematic detailed visual observations and photo and video documentation of modifications in superficial activity.

The OVSG is missioned for estimating the eruptive potential of the Soufrière volcano and keeping the authorities informed.

Again the civil security services, under order of the Prefect are in charge of managing the crisis. A volcanic event would however, as in 1976, imply evacuation of the population of 5 municipalities, and requires help and solidarity of the whole archipelago, if not a national solidarity.

Risk prevention and crisis management

The high volcanic risk lead to set up different mitigation systems in the last decades (DDRM, 2004)

- watch and alert by OVSG, in direct link with the Prefect
- information of population on the risk and situation of the volcano
- limited access to hazardous zones around the volcano
- integration of the volcanic risk in prevention plans for concerned municipalities (all of main island at different degrees)
- specific rescue plan (ORSEC)
- research programs

Volcanic activity is tightly watched, and can be forecasted. However it requires, during the crisis, the set-up of an ORSEC plan to allow and organise a population evacuation (in ranges depending of the type of events and total suspension of any social and economic activities during a long lasting event). Managing the crisis involves then other scales and dimensions as well as solidarity within or outside the regional territory, as it was the case during the 1976-1977 crisis.

Barriers, lacks and forces of the existing system

The focus of prevention and mitigation is made on a potential eruption of the volcano, due to the very high exposure of Guadeloupe and surrounding highland. Cascade and consecutive hazards (Ground movements, tsunami, soil weathering) are therefore little considered or disconnected from the volcanic risk management.
Volcanic crises require long-term management as is shown by the 10-year long eruption of the Soufrière Hills of Montserrat; The impact of this neighbour island on Guadeloupe also show the need of a supra-regional view of the volcanic risk.

Knowledge on exposure of the archipelago, as developed above, underlines that it is necessary to take into consideration long-term planning of land-use and development in Southern Basse-Terre area, particularly in terms of lasting infrastructures (industry, education, health, roads, bridges, crisis management centres).

Existing volcanic crisis rescue plans are to be updated to take into consideration new knowledge and concepts of transitional and evolutionary volcanic eruptive scenarios and probabilistic risk assessments.

4.5.4 Cyclones

Direct and secondary hazards

Tropical cyclones of different intensity (from high intensity-lower frequency hurricanes, to low intensity-high frequency tropical storms) impact heavily the Caribbean coasts. They induce a direct hazard due to cyclonic winds of different origins but also trigger secondary drivers such as wave surge, heavy rainfall, inducing inland and marine flooding, landslides and coastal erosion.

The high velocity of a cyclonic wind (>120 km/h) and its interaction with topography and existing developments induces direct damages to existing assets (buildings, banana fields). Due to the cyclonic trajectory of the wind, even if most cyclones come from the East, all faces of the archipelago islands are potentially affected.

Cyclones, but also tropical storms are likely to induce heavy rainfall and soil saturation, that itself can trigger ground movements and inundations such as inland barrier flood (“embâcle”) as it happened in January 2011 and May 2012 on the commune of les Abymes, inducing 4 deaths in January 2011. Those hazards are described individually further in this document, as they are also dealt with individually in the DDRM 2003.

High energy waves due to the wind induce coastal erosion. The coastal surge due to the wind and waves induces marine inundations.

Guadeloupe has been stricken by numerous hurricanes, such as the 1928 hurricane, inducing 1200 deaths, and more recently Hugo (1989), Lenny (1999), Dean (2007) and Omar (2008).

It is considered likely that cyclonic regimes might increase in intensity and frequency in the coming century (IPCC, 2007). This hazard is thus likely to increase.

Assets at stake

Hugo (hurricane of class 4, average winds 320km/h) induced 11 deaths, 107 injured people, but also 35 000 affected people, within which 25000 were homeless (MétéoFrance, 1989). The economic cost was assessed in a range of 4 billion euros (Guadeloupe Prefecture).

Lenny caused 9 deaths, 650 damages to (public) buildings, 1500 homeless families and an estimated cost of 735 million francs. Those figures are aggregating damages caused by all cyclonic-based hazards.

Lower intensity cyclonic and tropical storms are less damaging but very frequent from June to November and must be considered, notably by ground movement and inundations.

Coastal secondary hazards (erosion and marine inundation) are likely to affect urban surrounding and high ecosystemic value environments such as coral reefs and mangroves. Those ecosystems however appear to have a rather good resilience, in the present day cyclonic regimes, showing partial or total recovery between events.
Hypothesis on impact of climate change however is that high intensity events might become more frequent (Nicholls et al, 2006) in a context of warming climate (IPCC 2007).

**Monitoring**

MétéoFrance is in charge of predicting the likely occurrence of tropical cyclones, its intensity and trajectory, so to alert the stakeholders and population of the coming risk. This prediction is sustained by the permanent watch made in US, often stricken by the same hurricane events (NOOA/NHS).

Sea level rise due to storm surges are monitored by offshore buoys whose evolution is taken in charge by Météofrance.

Météofrance is to forecast alert the Prefect on meteorological events and induced phenomena such as rainfall and sea surges; the Prefect pronounce the alert level

**Risk prevention and crisis management**

Due to a relatively high probability of such events, education to such risk is developed and the population is prepared (as explained in the DDRM of Guadeloupe) to reduce at least the human risk, if not the dwellings. Dwellings have been adapted in the last decades to prevent from wind carried objects, such as concrete roofs or first floors, (those have been however lethal in the 2010 Haiti seism.

PPR have been elaborated for all Guadeloupe and incorporated into the multi-risk PPRN; however the study following the cyclone Dean underlined that PPR zoning was not complete in several points, by not taking in account the wave hazard. Updating the PPR implies modelling extreme waves and surges, in most unfavourable cyclonic conditions (Chauvet et al., 2007).

The alert levels are relatively well known by the population of Guadeloupe (colour levels from orange to red during the events, then purple and grey and back to green, to go back to normal). Preparedness and storage (water, food, candles, radio, batteries) to the cyclonic season was traditionally in the local culture, maybe less anchored in younger generations.

**Barriers, lacks and forces of the existing system**

Figures on economic and human damages of cyclone, such as given above do not discriminate if those damages are wind linked or due to secondary hazard. If prevention and preparedness is good for wind-linked damages prevention is to be designed more specifically for those cyclone secondary hazards and risk. Cyclones are, by themselves, a multi-hazard and are a good example of the need of a multi-hazard approach, towards a better knowledge of secondary hazards, and of their links to other hazards or intrinsic vulnerability of soil (weathered or non-cohesive soils). Cyclonic hazards zoning also is to be improved and updated, so to consider better wave and surge impact.

The “Cour des comptes” has recently (2011) put forward that the entire responsibility on watch or alert levels relies on the Prefect, and suggest such a responsibility should be restricted to the “red” situation, and sustained by MeteoFrance otherwise.

4.5.5  **Ground movement**

**Hazards**

The whole territory of Guadeloupe is exposed, at variable intensities, to ground movements (landslides, collapses, rock falls). Ground movement results from above quoted diverse and combined drivers (volcanic and seismic activity, tropical climate, heavy rainfall due to cyclones, weathering-prone soil).
The volcanic soils are strongly weathered during the wet season and undergo landslides often propagating as mud-flows; this hazard occurs mostly, in the steepest slopes of the Basse-Terre. Ashes deposits, consecutive to an eruptive activity may be remobilized by run-off, in the form of mudslide as it was the case during the Soufrière eruption of 1976. The volcanic cliffs and steep slopes, as well as calcareous cliff-forms, are exposed to rock falls of blocks, whose size and number is variable and sometimes transported on long distances.

Mudslides, torrential lavas and "embâcles" (stream obstruction) are not frequent but potentially very devastating. The deposits of ashes bound to an eruptive activity may be reshaped by rainfall into mudslides (e.g., during the 1976 eruption of La Soufrière volcano).

Ground movement and inundation are closely linked in most of the territory. Landslides can forms a natural "embâcle" in the streams, which breaking can create downstream a devastating wave. The destructive power is amplified with regard to a "normal" flood. Such phenomena occurred in Guadeloupe in particular following the disorders provoked by the earthquake of 1843 and in 1976 following the phreatic eruption of La Soufrière volcano.

Ground movements can also occur in very large number during and after major earthquakes (rock falls and landslides). It was the case during the major earthquake of 1843 and more recently during the earthquake of les Saintes in 2004, which occurred in a heavy rainfall period, leading to water saturation of the soils.

**Assets at stakes**

Landslides, collapses and rock falls are frequent in Guadeloupe and cause every year more or less important damages. All municipalities of Guadeloupe are more or less concerned.

The risks "landslides" and "embâcles" are present essentially in Basse-Terre and is increased where urbanization is important. The risk "collapse / falls of blocks" is present on all the territory, with variable intensity.

Ground movement can imply failures of road- and life-nets (as in Les Saintes, due to the 2004 earthquake, when numerous roads were cut due to landslides and rock falls).

Urban zones are often exposed, due to the combination of ground nature, slope and density of urbanization: In Pointe-à-Pitre zones highly exposed to ground movements are located in the south part of the city (Massabielle and Cour Zamia). In comparison, the municipality of Basse-Terre presents wider high hazardous zones, because of the pronounced steep slope and of the volcanic nature of grounds. However these zones, which are located in the southwest of the city throughout the "Rivière du Gallion" and the "Rivière aux Herbes" are less densely urbanized locally than Pointe-à-Pitre.

**Monitoring**

Ground movement hazard is assessed, in the Guadeloupe PPRN, on the base of the predisposition to move, due to slope and soil instability (weathering and water saturation).

For the movements exposing high stakes, surveys are led to try to follow and forecast the evolution of the phenomena. The realisation of geotechnical campaigns specifies beforehand the scale of the phenomenon. The implementation of survey instruments (inclinometer, topographic follow-up), associated with the determination of critical thresholds, allows to monitor the evolution of the phenomenon, detect an increase of acceleration of movement and alert if necessary. Forecasting occurrence of a movement limits the number of victims, by allowing to evacuate the threatened houses, or to close the vulnerable communications. However, needed improvement of knowledge of combination of various mechanisms governing stability, still refrain a secured forecast, as well as the scarcity of measurements in regards to the multiple potential movements.

**Risk prevention**

The multi-risk prevention plan (PPRN) takes into account the ground movements. It is made of the above quoted predisposition to hazard map and a reglementation map, that designs
zones of non-building, or building under restrictive conditions. It can also impose to act on the existing dwellings to reduce their vulnerability.

Following frequent and dangerous ground movement, in particular since the 2004 earthquake, various protective measures have been taken, along the road network of the department as a precautionary/curative measure. The most outstanding example in Guadeloupe is probably the RD23 which is frequently affected by hazardous ground movements. Numerous works have been done, to secure the main highway: construction of protection walls, strengthening banks, works of drainage of waters. Survey of the evolution of sensitive zones is regularly made to prevent of potential future landslides.

**Barriers, lacks and forces of the existing system for ground movement**

Ground movement is, by definition, a secondary hazard, than can be triggered by multiple possible forces and/or primary hazards.

Besides those triggering forces, Guadeloupe geology, climate predisposed this territory to ground movements such as mudslides, enhanced by a highly weathered and little cohesive soil, and rock falls of volcanic blocks and/or cliff edges.

A more extensive survey of the state and monitoring of soil weathering and water saturation, and of rock stability would help to gain a better apprehension of susceptibility to ground movement throughout the territory.

It is clear also that meteorologically induced ground movement and inland inundations are closely related, and can trigger each other.

The very common occurrence of ground movements, mostly triggered by meteorological events, lead in Guadeloupe to a high reactivity for post crisis recovery, through the municipalities technical services and delegated companies (Routes de Guadeloupe) when affecting infrastructures (road, electricity, water), as witnessed by the authors after the tropical storm Rafael (13-14 of October 2012).

Ground movement is considered as a major risk in the DDRM and integrated as such in the multi-risk PPRM of Guadeloupe; However, despite multiple drivers for this hazard, this refers more to management of risk consequences on the territory than to its causes, as quoted by an interviewee (DEAL).

4.5.6 **Inundations**

**Hazard**

Marine inundations induced by storm surge have been discussed above in this document as secondary hazards induced by cyclones. This chapter focuses on inland inundations, dealt individually in then the 2003 DDRM, and quoted by interviewees as recurrent and therefore major.

This hazard is mostly induced by heavy rainfall associated to cyclones and/or tropical storms that induce very rapid overflows of rivers (all municipalities of Basse Terre) and torrential floods. In Grand Terre, rain water accumulation, and insufficient capacity of natural or artificial drainage of valleys ("fonds") result in stagnating waters called "rain floods".

Those inundations are very rapid, violent and short lasting (starting a few hours after a heavy rainfall and lasting a few hours to a day). Intensive urbanization and soil impermeabilisation increases the phenomena

As said before, inland inundations are often linked to ground movements, either triggering those movements (bank erosion, water runoffs and weathering) or induced or aggravated by them.(embankment of a river).

**Assets at risk**
Most municipalities of the archipelago are prone to inundations; it often implies former urbanized zones, but also recent developments, that may be out of the regulation (new developments, precarious dwelling). This increases that risk, as well as soil impermeabilisation linked to urbanization.

**Monitoring**

Little monitoring can be made in such a hazard, due to the quasi aleatory intensity and position of the rainfall, the multiple parameters that induces an inundation (soil saturation and/or ground movements, and the short time lag between this driver and the inundation phenomena.

On the contrary to many regions in France or even in the neighbour island of Martinique, Guadeloupe does not have a service in charge of monitoring and forecasting floods (Service de Prévision des Crues: SPC): if potential zones have been identified in the PPRN, it is difficult to forecast locations and intensity of events it relies on alert on heavy rain, forecasted by Méteo France and pronounced by the Prefect, with the same codes as cyclone (from green to red).

**Risk prevention and crisis management**

A risk atlas was built in 1995 for all municipalities including inland inundation risk, formerly to the elaboration of PPRN (started in 1996). Those last documents pronounce a non-constructability in high hazard zones and prone restriction and recommendation of in building and drainage.

Drainage and protection works are been recently undertaken with a priority on sensible zones such as Jarry economic zone on the municipality of Baie-Mahault, where inundation could trigger cascade technological hazards.

Due to the application of the European framework directive on inundations, identification of high inundation risk territories (TRI) have been identified and projects of PAPI (projects of inundation preventions action) are currently calling to the national re-insurances Barnier funds .

**Barriers, lacks and strengths of the existing system for inundation.**

Like ground movements hazard, inundation is a “secondary” risk, triggered by heavy rains, consequences of cyclones or tropical storms, and enhanced by a predisposition of the territory to either torrential or rain floods. As ground movement, it is dealt with individually, considering more its consequences than its causes, despite the fact, as quoted by several interviewees, that there is a high interaction between occurrence of inundations and ground movements.

A common approach in the understanding of processes would likely benefit to both risks management.

Recent application of the European framework directive on inundation encouraged to set up action to mitigate the risk.

The high frequency of this kind of events should have increase preparedness and resilience of the population, thus decreasing assets at risk. However, the latest fatalities due to inundation,(Les Abymes in 2011 and more recently 14/10/2012 at St Claude), as well as numerous dwelling developments in hazardous zones, show that consciousness of that risk is still insufficient.

This, associated to a apparently good resilience of population and economy, if not fatalism to such events lead to little preventing actions. It is likely that such resilience is not so good when considering the cost to insurances, and would need to be evaluated in term of cost and benefits approach.
4.6 Other risks quoted by interviewees

Coastal and technological risks were not considered first in the desk study with the idea that coastal risks were not considered by the DDRM as "major", and that MATRIX focuses on natural risk.

However, those risk were quoted and discussed by the interviewees, and allow a more complete overview of risk governance in Guadeloupe.

4.6.1 Coastal risks

Hazard

Marine inundation and erosion linked to wave energy has been described here above as one of the cascade effect of cyclones, and are likely to increase, with climate change.

Those two hazards may also, at a smaller scale, be induced by local development of infrastructures and protections against the sea, when those are not planified in an integrated view.

Beaches evolution appears not to be only due to marine process, but also linked to inland erosion during high rainfall events, when flooding rivers high energy affect their output in the sea (such as Riviere Sens after the Rafael storm)

Assets at stakes

Most of Guadeloupean municipalities have a shoreface, apart from St Claude, and the coastal zone has a high population density. It is also where the touristic activity of Guadeloupe is highly developed, more specifically on the southern coast of Grande Terre.

Monitoring

Wave height and sea surges are part of the components of potential cyclones. The monitoring and alert is therefore in charge of Météofrance.

Risk prevention and management

As said before, information and prevention is associated to cyclonic prevention, so far that its cascade effect of marine inundation is sufficiently considered. At municipalities scale, prevention is made on wave energy, more in regards of swimmers risk (Fig).

Fig. 2.7 - Warning on surf risk- Municipality of Trois Rivières

At municipalities scale also, protection works, such as groynes, breakwaters and longshore rock ripraps have been undertaken locally to prevent erosion and marine inundation of backward infrastructures (Roques et al, 2010)
Barriers and forces
Protection against the sea have traditionally, in France, be taken in charge individually by
each municipality, not considering potential side effects on neighbour shores. The integrated
management of the coastal zone is a recent approach, fostered by Europe in the last
decades.
Not being considered as a major risk also impeded knowledge investment in Guadeloupe as
well as prevention and information measures.

4.6.2 Technological risks

Hazard
Technological hazard are not within the scope of Matrix study in Guadeloupe. However,
those risks could very likely be triggered by natural events; and this was quoted twice by
interviewees as potential cascade effects of natural hazards.
Most of industrial activities, potentially dangerous if damaged by a natural risk are located in
the low lying zone of Jarry, between the municipalities of Les Abymes and Baie-mahault. The
SEVESO sites for hydrocarbon or gas storage of SARA (hydrocarbon storage) and RUBIS
(gas storage), as well as GMA on Baie-mahault and GPAP at les Abymes (Raizet)
They can be potentially affected by a seism, the marine inundation cascade effect of
cyclones, as well as inland inundations (rainfall type) and lead to fire, explosion and soil and
water pollution

Assets
Those potentially dangerous points are next to the heavily inhabited tows of Les Abymes and
Lamentin. Besides, any technical event in the Jarry zone would also have heavy socio-
economic and environmental consequences, for this activity zone is the main one of few on
the archipelago.

Risk prevention and management
The frequency of inundation events has lead in the last decades the concerned
municipalities, together with the enterprise, to improve the drainage system. Each enterprise
is encouraged to build its own prevention. Internal emergency plans (Plans d'opération
internes-POI) are compulsory by law. This effort is sustained by municipalities and
Prefecture.
In case of a major hazardous event, alert is directly given inside the enterprise in order to set
up its POI

Barriers and forces of the existing system
Concerned interviewees (SIDPC and Municipality of les Abymes) considered it important that
 technological risks would be included in a multi-risk approach, considering the economic
assets at stake, that might have a long lasting impact on the whole archipelago. Technological risks are included as major in the DDRM, and specific measures are taken to
mitigate this risk.

4.7 Benefits and barriers to effective multi risk governance

Barriers
Preliminary results from the desk study of risk management underlined several points that
were consolidated by the interviews results. Those points can be considered both as barriers
or strengths.
Hierarchy in considering hazards and risks

Above described hazards can often be considered as multi-hazards as they can trigger other natural hazards. From this consideration, some hazards can be considered as major and primary, when induced effects would be secondary. Such hierarchy refers however more to the process than the intensity (e.g., a secondary hazard such as tsunami can be a major event).

From the interviews, present day governance also considers this hierarchy. It results from a classification of high intensity/low frequency events (seism, volcanism, cyclones) in regard to high frequency/low impact (Inland inundation and ground movement). Tsunami and coastal risks were quoted, but did not appear as major risks to interviewed stakeholders.

This hierarchy is a strength when considering major risks (earthquake, volcanism, cyclones), for which existing governance is well settled and proved its efficiency. It is a limit, for secondary events, despite their frequent occurrence, for which fewer investments in knowledge and prevention are made.

Risks awareness

As a corollary to this hierarchy in considering risk, desk study underlined different degrees in risk awareness that is also explained by intensity and recurrence of events and consequences on human assets. If the culture of cyclonic, earthquake and volcanic primary risks is well anchored in Guadeloupe at all levels of decision, it is less developed for secondary risks such as tsunami, landslides, marine and inland floods, coastal and slope erosions. Such a hierarchy will be different in other territories where the high-intensity and high frequency of individual hazards will give another hierarchy in risk consciousness.

The inquiry showed that Guadeloupean risk stakeholders have a strong culture of risks due to multiple major risks on their territory. It is likely that metropolitan stakeholders might be less aware of risk. Individual citizen consciousness however appear insufficient, leading to dramatic consequences of “small” events (Les Abymes, 2011, St Claude 15/10/12). It may be due to the insurance coverage of natural disasters (Catnat) that lead to a relative low concern of individuals, but also to a lack of efficient communication. All interviewees underlined the need of improved communication towards citizen, following the example of what has been done in the frame of Plan Seisme.

Risk awareness of stakeholders in Guadeloupe might be higher than in other French departments, where there is fewer major risks, with lower intensity and human threat. However, if this risk stakeholder high awareness is a strength for Guadeloupe, individuals low concern (likely to be common to other departments) is a barrier to mitigate or adapt to single and multi-risk

Top-down organization

The interviews underlined that most risk stakeholders are confident in a top down organization, where the department prefect is the focus for all decision making and that they are attached to their own function in this organization. This is to be taken as strength of the present-day governance.

It is to be remembered that the top-down organization of French administration is however geographically decentralized: the state representatives in the department (the Prefect and state services), at the head of this top-down pyramid are deeply involved in the departmental dynamics, and very aware of local challenges. The inquiry underlined a strong attachment of all stakeholders to this top-down organization, and to their respective functions in risk governance.

This organization of risk management also guarantees that all major risks are quoted in the different document from DDRM to multi-risk PPRN, which is a preliminary to a multi-hazard approach. Nevertheless, as confirmed by interviewees, this approach is still a compilation of single hazards, and would need a better integrative approach, by using GIS mapping tools and developing links between primary and secondary hazards.
Need for a supra-regional risk governance
The French organization refers to a departmental administrative level (with local state representation and collectivities). Some hazards, though (seismicity, volcanism, cyclones), need a more regional approach, if not supra-regional, on top of the national or departmental coordination.
It is already the case for cyclones alert, where MétéoFrance is associated with organisms from US and Central and South America. The long lasting volcanic event in Montserrat (ash clouds in 200, secondary tsunami on Western Guadeloupe coast) underlined, for interviewed stakeholders that a better supra-regional knowledge and management would have facilitate the management of secondary hazards, such as the ash cloud impact on Point à Pitre or the tsunami on Deshaies.
A supra-regional insight of risk would allow knowledge and risk assessment sharing but also help solidarity in crisis management and feedback from existing events.

Efficiency of the present-day risk governance
The desk study and the interviews did show little incoherency between prevention or emergency measures for single risk that would lead to conflicts. Coherence of construction codes for different risks could be improved between recommendations (between earthquake, volcanic and cyclone for example). The distribution of responsibilities in knowledge, policies, and crisis management appears to be efficient.
One point of conflict may appear, at municipal level, not due to risk governance but to the facts that responsibility of the mayor is engaged for the security of citizen, whereas he is also in charge of developing his town.
Some lacks were underlined for some single risks management in the desk study. Those lacks address mostly secondary hazards and refer to hazards knowledge (Inundation, secondary effects of cyclones) and management (Inundation, small stormy events, coastal risks, …). Those lacks impede a sound multi-risk approach of those risks.

Understanding of vulnerability and prevention
It also appears in most of the interviewees, that vulnerability is mostly understood as population vulnerability during the events, and considered as sufficiently known. Possible damage on economy and environment was little quoted, and apparently little assessed. However major events such as 1976 eruption at la Soufrière, or at a shorter scale impact of Monserrat Soufrière, were thought to have had largely affected the economy of the Archipelago.
Quoted prevention tools were mostly information and education, whether, as said above, considered not efficient enough. Mitigation or adaptations works were quoted, when the question was asked to the interviewees as dwelling adaptation of individuals, or coastal defence.
This comfort that the risk stakeholders priority in Guadeloupe is population safety, likely due to a high vulnerability of the population to several major risks. It must not however help from considering other aspects of vulnerability (economy, environment, … ) and prevention (works) that can impact the risk management in a longer term, and in its territorial dynamic.

Benefits
Input of a multi-risk approach
A multi-risk approach would sustain a good coordination of major risks management, and guarantee exhaustive governance.
Some cascade effect risks are already considered in a multi-risk approach such as site effects triggered by earthquakes, taken in account in microzoning of municipal territories. Safety plans (PCS), in progress in municipalities or enterprises to organize the crisis management, are asked to be built by considering all possible hazards whether natural social or technological.
Some risks are tightly linked such as frequent inland inundation and ground movements (landslides, streambed erosion), and several interviewees think that a common assessment of those risks would improve their management capacity.

Interviewees considered that a multi-risk approach would benefit mainly to gain a holistic view of natural risks on the territory, improve management of emergency and coherency of prevention/protection measures. Risk comparison allowed by a multi-risk approach did not appear as a main need to stakeholders.

Several interviewees underlined that a multi-risk approach cannot be subsidiary to a single risk approach: both approaches have to be done. This comment reinforces the result of the desk study: it underlined that knowledge of most single risk still has to be improved, or dealt with, individually, in terms of risk assessment and monitoring at the least. On the contrary, prevention, crisis management and recovery works would benefit of a multi-risk approach, avoiding conflicting measures, and saving investment in terms of cost/efficiency.

**Tools for a multi-risk approach**

Considering risks individually in the chapter 2 underlined a common need is for an exhaustive territory diagnosis, to help assessing vulnerability of assets to risks. Such a diagnosis must give a typology of the different components and help building a territorial database including demography analysis, to answer the priority identified by interviews to population safety but also economic data on public and private dwelling, road- and life-nets, agriculture, and environmental value of ecosystems and natural spaces. Such a data base would help assessments of potential or effective damages in relation to single or multiple hazards in a better integrated way.

Interviewed stakeholders in Guadeloupe consider that the existing organization can be the base for setting up a multi-risk approach, under the coordination of the Prefect within its regalian functions. Such a transversal plate-form would avoid redundancy with the existing system.

It would imply improving its exchange capacity by a better share of data as well on the territory as on risk management document, using numeric technology and GIS.

Above such a departmental organization, there is a need to up-scale this multi-risk approach to a supra-regional dimension underlined by stakeholders, as well in terms of knowledge, that in terms of management and solidarity, with neighbour islands sharing similar risks in an insular context.
Annex III: Interview protocol and list of interviewees (Italy)

Interview protocol

1) *Introduction by interviewer*
- Objectives of the Matrix project:
  - Demonstrate if multi-risk assessments, when cascading or concomitant effects, is more efficient (less conflict) than multiple “single-risk” assessment.
  - What is multi risk assessment: show figure 4 of deliverable and example of MATRIX Scenarios. Other possible (likely) scenarios
- Objective of interview: Task 6/subtask 6.3: Feedback of stakeholders experience

2) *Introduction*
Please briefly describe the role and responsibilities of your organisation and yourself, in regard to the following aspects:
Which natural risks are dealt with by your organisation?
Which aspect of risk management?
- Hazard/risk assessment
- Alert/warning/monitoring
- Preparation/prevention
- Crisis management
- Interactions of different types of risk (i.e., secondary effects, cascade effect)
- Integrating the results of the identified risks and vulnerabilities
- Vulnerability of physical structures
- Vulnerability of population groups
- others

How is your organisation structured and what resources are devoted in order to fulfil its role in risk management?
Which other actors cooperate with your organisation in managing the risks? (National level, regional/departmental/municipal level, other actors?)
Is there a hierarchy in risks? If so, is it due to intensity, probability, costs?....
Can you describe the coordination and communication channels among organisations?

3) *What is your opinion on single risks management (use tables and Likert scale or answer questions)?*
- on scientific terms
- exhaustibility of assessments (hazards/risks/vulnerability)
- capacity of prevention/prediction
- transfer from knowledge to risk management
- capacity of crisis management (warning/emergency management)
• on institutional terms
• inclusion of assessments in urban planning
• importance of the roles of the different institutional levels
• in knowledge and risk assessment
• in prevention and preparedness
• in crisis management

Communication/information/education:

• between institutional levels
• to citizens and implication of citizens
• existing tools
• on social and economic terms
• availability of resources, competencies, funds
• knowledge on exposed assets (fragility, values)
• knowledge on the systemic tree of the territory
• citizens information and preparedness

4) How is multi-risk assessment taken into account by stakeholders and policy makers?

Are you aware of existing multi-risk assessments in Naples?

In your opinion, what are the major vulnerabilities\(^8\) of Naples?

Do you consider they can be addressed in a multi risk perspective?

How would an unexpected/worst case multi-risk scenario (especially in terms of cascade effects) taken into account in the present risk assessment and/or emergency planning?

Do you think the study of (i) interactions among risks and (ii) cascade effects is relevant with regard to your activity? Would such approach help your organisation to better perform its objectives of risk assessment/prevention/emergency planning etc. (depending on the organisation)?

Do you think that multi risk assessment could be part of the everyday practices of your organisation and others in risk management?

If so, what would the main barriers/conflicts? What would be the benefits?

In Matrix we are working on the following multi risk scenarios (examples for Naples)

What could be the role of your organisation in the scenarios taken as example?

What could be the possible steps towards adoption of a multi-risk approach? (e.g.: an inter-organisation organisation, a specific organisation, one of the existing organisation to be in charge of such an approach?)

If so, what authority should be in charge of taking into account interactions among risks/cascade effects? At what level (national/regional/departmental/municipal)?

Which technical tools would help such a multi-risk assessment?

• GIS
• Knowledge of pre-dispositions (e.g. soil weathering, slopes etc....)

\(^8\) Which assets exposed to which hazards?
• Which policy tools would help such a multi-risk assessment?
• Territory diagnosis
• Supra-regional approach of hazards (seismic, volcanism, cyclones,…)
• ….

List of interviewees

<table>
<thead>
<tr>
<th>Name</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ing. Mario Biafore</td>
<td>Settore Programmazione Interventi di Protezione Civile Regionale</td>
</tr>
<tr>
<td>Vincenzo Cincini</td>
<td>Sala operativa regionale della Protezione Civile</td>
</tr>
<tr>
<td>Dott.ssa Daniela Lombardo, Dott. Luca Acunzo</td>
<td>Settore Foreste della Regione Campania</td>
</tr>
<tr>
<td>Arch. Marianna Cerillo</td>
<td>Settore di protezione civile comunale di Napoli</td>
</tr>
<tr>
<td>Arch. Francesca Pignataro</td>
<td>Settore urbanistica comune di Napoli</td>
</tr>
<tr>
<td>Ing. Guido Parisi, Ing. Luigi Giudice</td>
<td>Vigili del fuoco provinciali</td>
</tr>
<tr>
<td>Ing. Vincenzo Marrazzo</td>
<td>Autorita’ di bacino regionale della Campania centrale</td>
</tr>
<tr>
<td>Dott. Marcello Martini</td>
<td>Istituto Nazionale di Geofisica e Vulcanologia</td>
</tr>
<tr>
<td>Dott. Pompeo Coico</td>
<td>Regione Campania, Settore ecologia, tutela ambiente, disinquimamento e protezione civile</td>
</tr>
<tr>
<td>Prof. Giovanni Battista Chirico</td>
<td>Universita’ di Napoli</td>
</tr>
<tr>
<td>Ing. Rosario Manzi</td>
<td>ARCADIS, Agenzia regionale Campania di difesa del suolo, Comparto Frane</td>
</tr>
<tr>
<td>Dott.ssa Fiorella Galluccio, Dott. Giuseppe Esposito, Dott. Raffaele Bordo</td>
<td>Dipartimento Difesa del suolo, Regione Campania</td>
</tr>
<tr>
<td>Dott. Luigi Carnevale</td>
<td>Regione Campania Area Agricoltura - Settore Tecnico Amministrativo Provinciale delle Foreste di Salerno</td>
</tr>
<tr>
<td>Ing. Federico Baistrocchi</td>
<td>Autorita’ di bacino del Sarno</td>
</tr>
<tr>
<td>Ing. Vincenzo Di Muoio</td>
<td>Dirigente di Settore, Genio Civile Provinciale di Salerno</td>
</tr>
<tr>
<td>Dott. Giovanni Romano</td>
<td>Assessore Ambiente, Infrastrutture, Protezione Civile, Risorse Mare, Provincia di Salerno</td>
</tr>
<tr>
<td>Dott. Domenico Ranesi</td>
<td>Dirigente per i settori di agricoltura e foreste, attivita’ produttive e mercato del lavoro, innovazione tecnologica e informatizzazione, protezione civile, Provincia di Salerno</td>
</tr>
</tbody>
</table>

Regional Civil Protection
Operative room of the Regional Civil Protection
Forestal Sector of the Campania Region
Municipal Civil Protection service
Municipal Urban Planning Office
Provincial Fire Brigades (province of Naples)
Regional River basin Authority of the Campania Region
National Institute of Geophysics and Volcanology
Sector Ecology, environmental protection, pollution and civil protection, Campania Region
Naples University
Regional Agency for Soil defence, Region Campania
Soil Defence Department, Region Campania
Campania Region, Provincial Technical and Administrative Sector- Forest Management, Province of Salerno
Sarno River Basin Authority
Genio civile, Salerno Province
Environmental, Infrastructure, Civil Protection, Marine Resources Councillor, Province of Salerno
Director of the sectors of Agriculture and Forests, Productive Activities, Technological Innovation, Civil Protection, Province of Salerno
Annex IV: Interview protocol and list of interviewees (Guadeloupe)

The interview protocol for Guadeloupe was built following the protocol that was practiced in Italy (see Annex III) with some adaptation to the specific hazards of Guadeloupe and enriched by questions emerging from the desk study on Guadeloupe.

The interview protocol was prepared beforehand. Some questions were not asked when answered spontaneously. Marking following the Likert scale was sometimes asked, to help interview evaluation.

The first part was a presentation, with help of a 4 pages support document, of MATRIX project as whole, describing tasks and objectives, and giving preliminary results, then focus was made on task 6.3 objectives. Several figures were shown to underline links between hazards. Interviewees were given a support document to sustain the presentation.

The second part aimed to get information on the interviewee function within his structure and this structure role in risk governance.

Questions asked were:

- Name and function in the organism
- Which risks does your organism deal with?

Which aspect of risk does your organism deal with?

- Risk assessment
- Preparation/prevention actions
- Crisis management
- Interaction between risks
- Vulnerability to hazards (dwellings, infrastructures, population,…..)
- Others

- How is your organism organized and which resources (human, financial) are dedicated to risk management?
- What is your own function in risk management?
- Which other organization do you work with, for risk management?
- Can you describe the organization between organisms?
- What are the modalities (orders given by, fundings, operators)?
- free comments

The third part aimed to collect interviewees’ advice on existing risk governance for single risks.

- Questions asked: Is single risk assessment exhaustive? (mark from 1 to 7)
  - Hazard assessment
  - Forecasting capacity
  - Vulnerability assessment to this hazard
  - Prevention capacity

- Is there knowledge for these risks on:
  - Exposed assets fragility (i.e., dwellings, lifelines, enterprises, agriculture,…..)
  - Value (financial, human, strategic,…..) of exposed assets
- Interaction between exposed assets?
  - In case of a crisis, on availability of resources and competencies, other than in your organism?
- Is knowledge transfer sufficient between scientists and risk governance stakeholders? *(mark from 1 to 7)*
- Is crisis management sufficient (in terms of alert and emergency management)? *(mark from 1 to 7)*
- Are documents on risk assessment included in urban documents?
- How are communication, information and education made on this risk?
  - between risk stakeholders?
  - towards population?
- Which are the tools?
- Which efficiency (mark 1 to 7)?
- How much are citizens implied?
- free comments

The last part of the interview focused getting interviewees advice on a multi-risk approach

Questions asked were:

- Do you know of multi-risk assessment approaches in Guadeloupe?
- Do you know of cascade or concomitant hazard events in Guadeloupe? Were they dealt with individually or together?
- Do you think that cascade effect or concomitant risk are considered in the present-day risk management? *(mark 1 to 7)*
  - in terms of forecasting/prevention
  - in crisis management

- Which risks do you think would benefit to considered in interaction with other risks?
- Would a multi-risk approach be pertinent in your activity, and in your organism's activity?
- For you, which is the main aspect of a multilink approach in the following list? *(mark each aspect from 1 to 7)*
  - Quantitative comparison of risk
  - Taking interaction (cascade effect) in account
  - Holistic vision of all natural risks (e.g., to avoid increasing one risk by decreasing another)
  - Emergency organization

- What would be the barriers to a multi-risk approach?
- Which organization would be necessary to settle to help a multi-risk approach? *(a transverse organization between existing structures, a new structure, leadership of an existing structure? Under which authority?)
• Which tools and developments would facilitate a multi-risk approach? (GIS, regulation, better knowledge, up and down scaling, ...)?

**List of interviewees**

As described in Annex II, risk governance in Guadeloupe implies several levels of actors in risk management: risk prevention is relying on knowledge and expertise of diverse organisms and is managed by the state representation for environment. Collectivities at regional and departmental level are mainly implied in financially sustaining a better knowledge.

Crisis management is referring to a strong top-down organization where the Department Prefect is the main reference, in association with the Civil security service. At municipality level, the mayor or his delegate to security are in charge.

The interviews were therefore focused on those different agencies:

- N. Cormier deputy director of the Civil Security service on behalf of the Departmental Prefect, as crisis management coordinator, and policy makers in multi-risk prevention
- Three representatives of the DEAL as managers of single risk prevention: G. Steers, in charge of the natural Risk division, F. Varin, in charge of seismic hazard and P. Thénard, in charge of PPRN. They were interviewed together.
- M. Joyau, Director of the environment for the Regional counsel, as part of regional working groups on risk, and funding studies and surveys on shoreline evolution.
- Municipalities services of Les Abymes (Mr Gayroso, General director of services, Mr Bibiani, General director of technical services) and Trois Rivières (G. Siarras, Deputy director of the security and reglementation services) were interviewed, as the mayor is responsible for risk information, prevention and crisis management in their territory. The focus was made on municipalities where several hazards may occur, where the development is increasing the risk.
- BRGM is part of the MATRIX multi-risk assessment for Guadeloupe and is locally strongly involved in developing knowledge and management of seismic and ground movement risk knowledge, in collaboration with other organisations. Our own experience, through J. M. Mompelat, head of BRGM Guadeloupe, was considered as representative of organisations associated with risk management.
# French Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIDPC</td>
<td>Service interministériel de défense et de protection civile</td>
</tr>
<tr>
<td>DEAL</td>
<td>Direction de l'environnement, l'aménagement et le logement</td>
</tr>
<tr>
<td>DDTM</td>
<td>Direction départemental des territoires et de la mer</td>
</tr>
<tr>
<td>BRGM</td>
<td>Bureau de recherche géologique et minière</td>
</tr>
<tr>
<td>INERIS</td>
<td>Institut national de l'Environnement Industriel et des Risques</td>
</tr>
<tr>
<td>IRSTEA</td>
<td>Institut de recherche scientifique et technologique pour l'Environnement et l'agriculture</td>
</tr>
<tr>
<td>IRSN</td>
<td>Institut de recherche en sécurité nucléaire</td>
</tr>
<tr>
<td>CNRM</td>
<td>Centre National de Recherche météorologique</td>
</tr>
<tr>
<td>CIRED</td>
<td>Centre international de recherche pour l'Environnement et le Développement</td>
</tr>
<tr>
<td>IGBP/OVSG</td>
<td>Institut de physique du Globe de Paris/Observatoire volcanologique et sismologique de Guadeloupe</td>
</tr>
<tr>
<td>ONF</td>
<td>Office National des forêts</td>
</tr>
<tr>
<td>DDRM</td>
<td>Document départemental des Risques majeurs</td>
</tr>
<tr>
<td>DICRIM</td>
<td>Document d'information communale sur les risques majeurs</td>
</tr>
<tr>
<td>DCS</td>
<td>Document communal synthétique (sur les risques majeurs)</td>
</tr>
<tr>
<td>CPER</td>
<td>Contrat de plan Etat-Région</td>
</tr>
<tr>
<td>FEDER</td>
<td>Fond européen de Développement en région</td>
</tr>
<tr>
<td>PLU</td>
<td>Plan local d'urbanisme</td>
</tr>
<tr>
<td>POS</td>
<td>Plan d'occupation des sols</td>
</tr>
<tr>
<td>PSSS</td>
<td>Plan spécifique de Secours (seisms)</td>
</tr>
<tr>
<td>PSSV</td>
<td>Plan spécifique de Secours (volcanisme)</td>
</tr>
<tr>
<td>PCS</td>
<td>Plan communal de secours</td>
</tr>
<tr>
<td>ORSEC</td>
<td>Organisation de la réponse de sécurité civile</td>
</tr>
<tr>
<td>COGIC</td>
<td>Centre opérationnel de gestion interministérielle des crises</td>
</tr>
<tr>
<td>COZ</td>
<td>Centre opérationnel de zone</td>
</tr>
<tr>
<td>DOS</td>
<td>Direction des opérations de secours</td>
</tr>
<tr>
<td>COS</td>
<td>Commandant des opérations de secours</td>
</tr>
<tr>
<td>COD</td>
<td>Centre opérationnel Départemental</td>
</tr>
<tr>
<td>PCO</td>
<td>Poste de commandement opérationnel</td>
</tr>
<tr>
<td>PCC</td>
<td>Poste de commandement Communal</td>
</tr>
</tbody>
</table>

State representative in Region/Department

Organisations in charge of hazard assessment and monitoring

Information on major risk

Funds

Urban and land use documents

Preparedness plans for emergency

Emergency organisation
Bibliography


Citta’ della Scienza (2008), Methodology management of natural disasters, MEDRISK - Mediterranean Risk Management del “PROGRAMME INTERREG III B ARCHIMED”.


Department of Agricultural, Campania Region (2012), Piano antincendio boschivo, Regione Campania, Napoli.


EEA, European Environment Agency (2010), Mapping the impacts of natural hazards and technological accidents in Europe. An overview of the last decade, EEA, Copenhagen.


IRGC, International Risk Governance Council (2009), Risk Governance Deficits: an analysis and illustration of the most common deficits in risk governance, IRGC, Geneva.


Pellizzoni L. (1992), Civil protection and emergency planning in Italy, Quaderno 92-1, Mass Emergency Programme, Gorizia, ISIG, 1-43.


Communities to Disasters United Nations Development Programme Geneva


Wright D., Dressel K., Merad M. (2006), Stakeholders in Risk Communication (STARC) – Risk communication practices in EU Member States, selected other countries and industries. Deliverable 2. D. Wright.


Main consulted websites

http://www.developpement-durable.gouv.fr/La-carte-communale.html
http://www.risquesmajeurs.fr
http://www.interieur.gouv.fr/sections/a_l_interieur/defense_et_securite_civiles/view
http://www.eu-medin.org
http://ec.europa.eu/environment/soil/index_en.htm
http://www.minambiente.it/
http://www.protezionecivile.it/index.php
http://www.pcn.minambiente.it/PCN/
http://www.statoregioni.it/
http://www.difesa.suolo.regione.campania.it/content/view/23/56/
http://www.commissario2994.it/
http://www.gndci.cnr.it/
http://www.ispro.it/site/
http://www.isprambiente.it/site/en-GB/

WP6_Task 6.3
http://www.irpi.cnr.it/padova/index.htm
http://www.irsia.it/?idcat=388
http://www.rendis.isprambiente.it/rendisweb/
http://www.difesa.suolo.regione.campania.it/component/option,com_frontpage/Itemid,1/
http://esse1.mi.ingv.it/
http://www.cig.it/