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Building resilience towards natural hazards: cross-scale knowledge and institutional linkages

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LIST OF ABBREVIATIONS

ANCI - Association of Italian Municipalities (Associazione Nazionale Comuni Italiani)
CEP – Civil Emergency Planning
CRED – Centre for Research on the Epidemiology of Disaster
DCP – Department of Civil Protection
DHI – Danish Hydraulic Institute
ECHO – European Commission Humanitarian and Civil Protection
EU – European Union
GDP - Gross Domestic Product
GHGs – Greenhouse gases
GISs – Geographic Information Systems
GST – General System Theory
IPCC - Intergovernmental Panel on Climate Change
IT – Information Technology
KM – Knowledge management
KV – Kristianstad Vattenrike
LDCs – Less Developed Countries
MAB – Man and Biosphere
MDCs – More Developed Countries
MSB - Swedish Civil Contingencies Agency (MBS = Myndigheten för Samhällsskydd och Beredskap)
NCPS – National Civil Protection Service
NHS – National Health Service
OECD – Organisation for Economic Co-operation and Development
PAR – Pressure and Release Model
PCE – Local Emergency Plan (Piano Comunale di Emergenza)
PPRR chain – Prevision- Prevention-Response-Recovery chain
RH – Risk-Hazard Model
SDI – Spatial Data Infrastructure
SEA – European Strategic Environmental Assessment Directive
SEMA – Swedish Emergency Management Agency
SES – Social-Ecological System
SGI – Swedish Geotechnical Institute
S.I.S.M.A. – System Integrated for Security Management Activities
SMHI – Swedish Meteorological and Hydrological Institute
SPF – National Board of Swedish Psychological Defence
SRD – Data Entry System (Sistema Raccolta Dati)
SRSA – Swedish Rescue Services Agency
UN – United Nations
UNESCO – United Nations Education, Scientific and Cultural Organisation

UNISDR – United Nations International Strategy for Disaster Reduction
UNWCED – United Nations World Commission on Environment and Development
WP – Working Package

INTRODUCTION AND METHODOLOGY

The overall aim of this research is the exploration of a new path of planning for resilience that responds to the increasing uncertainty in the context of global 'risk society'. It would contribute to the new dynamic of safety and security by drawing on risk dimensions modifications. Several areas of knowledge are developed within this research aimed to improve ways of governing society resilience that covers the continuous system for mitigation, readiness, and resistance in the context of risks. Out of that, new areas of collaboration are identified among urban and emergency planners, decision makers, and the citizens to strengthen societal resilience. Thus, the main question of this research is: *What are the challenges that planning is facing in the increasing uncertainty?*

Our environment is becoming increasingly complex: the rapid urbanisation, often accompanied by uncontrolled use of land, occupation of unsafe environments as well as the increased rate of occurrence of climate events are introducing elements of uncertainty (Pinna, 2002). The idea of certainty or security that was fundamental to risk management in the past, collapses. In this context, the notion of 'risk society', introduced by Ulrich Beck in 1992, is considered as a shifting paradigm in world security, where our modern society becomes ever more interdependent and more complex, and consequently more vulnerable to threats and risks. Traditionally, planning plays a central role in the scientific management of risks mostly based on the control of calculated risks. But, the increasing uncertainty and the emerging of new types of risks require an alternative path of planning practice that acknowledges and interacts with society's risk implications. Despite its lack of clarity, resilience offers opportunities to the uncertainty and insecurity of contemporary context (Davoudi et al., 2012). The concept of resilience was early adopted in the field of ecology and resource management while in the urban planning resilience remains largely unpractised. This research will explore the potential of planning to acknowledge the new concept of security and how to operationalize planning to identify, enable and mobilize the physical, intellectual, social and cultural resilience elements of society.

To respond to the overall point in question, the research consists of four parts that are interlinked and enhancing each other: the first and the second will organize ideas and theories inspired by four pillars, which are risk in its new perspective, contemporary risk management, the resilience thinking and the knowledge planning to address the complex and interacting challenges of the new uncertainty system. The third part corresponds to the cross-comparative analysis of different political measures and practices in order to strengthen resilience. Two cases are observed from different European contexts and type of risk. The conclusions of the thesis are the last part of this research and reflections on the outcomes of this work and methodology, as well as potential future direction for the research.

Chapter I. Theoretical ground of planning for resilience

The first part of the research explores the nowadays challenges of increased uncertainty and the emergence of new types of risk in our cities brought about a growing pressure. The main theories investigate the contemporary risk society and the resilience concept, to build theoretical ground of the thesis. The research questions of this part are: *What are the roots of the 'resilience' concept and what is its use in the domain of security in increasing uncertainty? What are the key dimensions of 'resilience' that suggest a new path of planning theory and practice in risk management?* The two main themes debate are[1]:

1) Risk Society

In the context of unknowable, unpredictable and uncontrolled perspective of risk, Beck's thesis on 'risk society' introduced in 1992 has opened an interesting debate. In his work Beck (1992) explains that risk is beyond the prospects for control and measurement since we all live in a global risk society. This turns traditional assumptions about planning and managing the future as inappropriate and overtaken by their failures to secure any calculable future. Beck emphasizes that risk implies decision-making, but in the face of unknown factor of crisis potential, decisions are increasingly impracticable. In the face of hazards that escape from the logic of control, the challenge is to find ways of relating risks to decisions and practices.

2) Resilience as an emerging concept into planning

The emerging of the 'resilience' concept signals a change from disaster risk reduction planning where responsibility rests with public authorities, to self-risk management where responsibility rests on individual social actors (Sapountzaki, 2007). The social risk thesis of Beck (1992) confirms the presence of a broader transfer of responsibility for risks from institutions to individuals. In his view, public reflexivity emerges as a response to the intensity of risks and the ineffective responses of institutions. This assumption is also promoted by the evolutionary resilience defined by Davoudi, Brooks, & Mehmood, (2013) as a way of enhancing preparedness to future transformations.

Chapter II. Theoretical part of knowledge planning

The knowledge as decision-making tool is considered in this research as directly relevant to the risk society approach. To this aim the second part investigates the contemporary risk management and the role of knowledge and how to manage it. The questions of this part are: *Which are the areas of action and at what level in order to strengthen safety? Which is the role of knowledge planning?*

[1] The main literature review done to develop the first part of the thesis concerns:

- Increasing uncertainty: UNDP, UNISDR, Renn
- Risk society: Beck
- Resilience concept: Holling, Gunderson, Walker, Simmie & Martin, Davoudi

Also the second part is divided in two main sessions. The former concerns the contemporary risk management and the scale dynamics, while the latter investigates the role of knowledge and different approaches to build and share it[2].

3) Contemporary risk management

Risk management is a multi-disciplinary mix of professions and theories. It is characterized by uncertainty, complexity, instability due to the number of stakeholders involved, space and time extension, the potential of damage and number of people affected. A pluralism of professions are involved at different levels. Risk management is composed by different parts (called PPRR-chain) and a myriad of actors are involved in each step (Koraeus, 2008). At the beginning, there are the pre-disaster or preventive planning covering activities which vary from the construction of defensive engineering works to land use planning and elaboration of evacuation plans. During emergency they refer to reaction activities immediately before and after and emergency relief operations. Finally, after a catastrophic event, there are actions for returning to normal, this means a more or less long time. Nowadays, these interactions between the different parts are managed by norms and procedures but scaling problems still persist. Each phase of the risk management chain has to combine data and models at different spatial and temporal scales, or also extrapolate information between scales and levels.

4) The role of knowledge

The 'evolutionary' notions of resilience and risk society add necessity to the well-established knowledge. The connection between resilience and risk society brings to planning the view of the ecological, the safety, and the society as intrinsically interlinked. All forms of knowledge seem fundamental for understanding transformations of complex social-ecological systems and play a vital role in communicating the ideas of risks and resilience elements among wider social networks as fundamental condition of the society to face threats. Knowledge systems and learning processes are characterized by new dynamism that requires new solutions.

Chapter III. Cross-comparative analysis of cases within Swedish, Italian dimensions

In the third part the research includes cross-comparative analysis of two case studies on the Swedish and Italian contexts. Cases are selected from different contexts and types of natural risks. Despite the different contextual characteristics of each case, evidences obtained from cross-comparative analysis in light, with systematic theory-based comparison, will support the understanding of the role of knowledge planning in a context

[2] The main literature review of the second part includes:

- Risk management and PPRR chain: Smith, White, Wilbanks, Bignami
- Scale dynamics: Gibson, Berkes, Folke, Cash, Cai, buizer, Ostrom
- Data, information, knowledge: Polanyi, Koraeus, Langefors
- Building and sharing knowledge: Argyis, Schön, Comfort, Crosta, Easterby-Smith, Hahn, Pahl-Worst, Wenger

of increasing uncertainty. (Gillham, 2000), and (Yin, 2009) argue that case studies are particularly useful to understand a specific problem or situation in great depth, and have a desire to appreciate complex social phenomena. The cross-comparative analysis between the different cases will provide reflections on the knowledge management-like techniques in search for traces of knowledge management and learning processes and arrangements. Investigations are made on how they have been used and if they have had any significant impact on the management. Through the two cases some questions are explored: *How resilience is governed before, during and after the threats? How can institutions of government and societal management effectively engage the externalities of the unknown? Which role has knowledge for practitioners? Which is the linking point between knowledge and action? How can be strengthened the role of the citizens in building societal resilience and make use of the social media to provide technical support to communicate risks, identify resilient elements and simulate scenarios?*

The methods used to complete this stage of the research concern: critical review of documentation, analysis of policies and plans, law and regulations and interviews to the people involved in the initiatives. The outcomes of this case studies analysis answer the research questions and help to identify similarities and differences among the cases.

Chapter 4. Conclusion. Implications of bridging theory to practice

At the end of the path of research, the conclusions respond to the main research question: *What are the challenges that planning is facing in the increasing uncertainty?*
Planning for resilience in the context of risk society is essentially interdisciplinary. This research involves considerations that differ, vertically, through working at multiple levels from global to local and from the theoretical to the practical and, horizontally, through employing a wide range of disciplines. In addition to the reflections on the research path, its outcomes and its methodology, the last part of the thesis concerns potential future directions for the research.

1. RESILIENCE: A PERSPECTIVE FOR SOCIAL ECOLOGICAL SYSTEMS

The first part of dissertation provides the theoretical and conceptual framework for the research. Its main objective is to define the ground of planning for resilience and to explain why nowadays it is widespread the use of the concept of resilience in environmental as in social sciences. Building this first part permits the definition of the research question.

The first chapter (1.1.) is an introduction on the challenging period we live in characterised by the constant reminder of unpredictability of catastrophic climate events, terroristic attacks, economic crisis, or mass failures of infrastructure systems. Indeed, the increase of economic and physical well-being have created longer life expectancy and increased the global population with a consequent intensification of human activities and pressures on territories. At the same time we witness the "shrinking" of the globe because of events that, though happening in a restricted are, generate consequences that have a global impact (e.g. Chernobyl, global warning, September 11 terrorist attacks, financial crisis started in 2008 and not over yet, etc.). In this context, Beck's thesis on "risk society" (see 1.1.1.), introduced in 1992, has initiated a new debate that challenges the social science tradition. In his work, Beck argues that the nature of contemporary risks is unprecedented in terms of their spatial, temporal, and potential impact and of their invisibility and since traditional categories for control and measurement of risks are not longer valid. To face of hazards that escape the logic of control, the challenge is to find new ways of relating risks to decisions and practices[3].

In order to build the theoretical ground, the 1.1.2 and 1.1.3 will investigate the concepts of vulnerability and risk, whereas later, it will explore the literature on resilience concept, going from the engineering approach to the evolutionary one (see 1.2.). This approach has been chosen because vulnerability and resilience though related, are yet different concepts in the field of the challenges posed by the environmental change, social context or global economy. Usually, the terms vulnerability and resilience refers to two different

[3] The terms disaster, hazard, risk and vulnerability will be deeper explore in Chapter 1.1., 1.1.1., 1.1.2. and 1.1.3. However, here is provided a a basic definitions on these concepts developed by UNISDR to promote a common understanding on the subject for use by the public, authorities and practitioners (http://www.unisdr.org/we/inform/terminology). Some of these terminologies will return also later.
"Disaster= A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources. Disasters are often described as a result of the combination of: the exposure to a hazard; the conditions of vulnerability that are present; and insufficient capacity or measures to reduce or cope with the potential negative consequences.
Hazard= A dangerous phenomenon, substance, human activity, or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.
Risk= the combination of the probability of an event and its negative consequences.
Vulnerability= The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard."

approaches to the problems under investigation: the former is more related to the ecological-biophysical dimension, whereas the latter focuses more on the social political issues. As Miller et al. (2010) argued the epistemological tension between the two terms is mostly caused by the research communities related to these terms and how either communities conceptualize systems and changes. Miller also theorized that vulnerability and resilience are complementary and he explored the need of integration between the two terms to reach a set of common conceptual and methodological principles able to guide new claims for future management and governance.

The term vulnerability has been theorized in hazard studies and in response capacity in regional sciences (Eakin & Luers, 2006; Simmie & Martin, 2010; Smith, 2009). On the other hand, the epistemic and academic contributions to resilience theory have primarily come from natural sciences, and in particular ecology (Holling, 1973; Pendall, Foster, & Cowell, 2010; Simmie & Martin, 2010), but nowadays it is spread also to social sciences (Berkes & Folke, 1998; Folke, 2006; Gunderson & Holling, 2002).

Vulnerability is seen as a condition related to exposure, susceptibility, sensitivity, coping and adaptive capacity related to "calculated risks". Therefore, differently by resilience, vulnerability is shaped by dynamic historical processes, differential entitlements rather than being a direct outcome of a perturbation or stress (Eakin & Luers, 2006; Miller et al., 2010). Resilience, on the other side, includes different critical features as persistence, adaptability and transformability to "uncalculated risks" (Resilience Alliance, 2010). The core of resilience lies in the interactions among system components and consequently the role of institutions, social capital, leadership and learning. In risk management, the resilience approach has increased and it is always more applied to institutional responses to climate change solutions in livelihood transformations.

However, the common ground between vulnerability and resilience approach concerns the way systems response to stresses or perturbations, while the difference can be found in the way each community considers systems.

Vulnerability focuses on the understanding of ecological and biophysical processes - in particular the distribution of costs, risks and benefits - in order to anticipate, adapt to and manage change. Resilience instead emphasizes system dynamics and interconnections, social-ecological relations and feedbacks.

However, the many definitions and approaches to vulnerability and resilience reveal the multifaceted nature of the problems under inquiry. Because of this multidisciplinary and fragmented nature of the topic and the absence of a dominant paradigm within the literature, the following chapter does not want to be exhaustive, but it aims to define the theoretical framework of this research.

In particular, this research suggests maintaining the essential role of planning as decision-making activity managing the future of a society. Nonetheless, the shifting paradigm in risk perspective requires an alternative path of planning, so to maintain its role. A path that acknowledges the implications of social security where the assumption is not to control a defined and measurable "risk", but to make an uncertain future

manageable. For these reasons in its first part this work addresses the following questions:

1. *What are the roots of the 'resilience' concept and is its use in the domain of security in increasing uncertainty?*
2. *What are the key dimensions of 'resilience" that suggest a new path of planning theory and practice in risk management?*

1.1. Living with perils

Disasters have affected people since the beginning of our existence. The term disaster derives from the Greek negative prefix *dis*- ("apart") plus *aster*, which means "bad star" and refers to the idea that a catastrophe could be traced to the negative influence of a star or a planet. Nowadays the contemporary definition of disaster is not longer linked to the original meaning of the word and the most common definition - given by the Centre for Research on the Epidemiology of Disaster (CRED) -defines a disaster as "*a situation or event which overwhelms local capacity, necessitating a request to a national or international level for external assistance; an unforeseen and often sudden event that causes great damage, destruction and human suffering"*. Thus, the main challenge in this field, compared with its original meaning, is the rejection of fatalism and the acknowledgement of disaster as a consequence of inappropriately management of the ecosystem. In reality, this is true merely in the academia field, because people still use to relate disaster mostly with fatalism and they often have an underrated perception of risk.

The nowadays paradox of the rate at which disasters have unfolded in recent years regardless of human progress and the contemporary increase of feelings of insecurity is only apparent (Smith, 2009). Economic development and environmental hazards are deeply bounded. The growth of population, the rapid urbanisation (urban population in 2009 accounted for more than half of total global population) and the intensification of agriculture pressurise the impact of human activities on natural systems.

This is the reason why humans are not simply the victims of environmental hazards but they are also the first origin of hazard processes and disaster outcomes. Human activities have a double impact in the damages caused by catastrophic events: the increase of infrastructures as well as the failure to impose building codes or implement earthquake-resistant techniques are mainly responsible for collapses and human loss; furthermore the shock of a severe disaster can create a cascade of disruption among interdependent elements that shatters the whole system. At the same time, human activities are also responsible for the forced increase of natural events due to the global warning and outburst of greenhouse gases (GHGs) concentrations in the atmosphere.

Some statistics. In 2012, the CRED analysed that the number of disasters in that year was less that the average annual frequency observed from 2002 to 2011 (357 rather than 394). But even if, to a less number of events have corresponded a decrease of human impacts and people lost, at the same time, the economic damages from natural disasters show an increase to above average levels (see Figure 1).

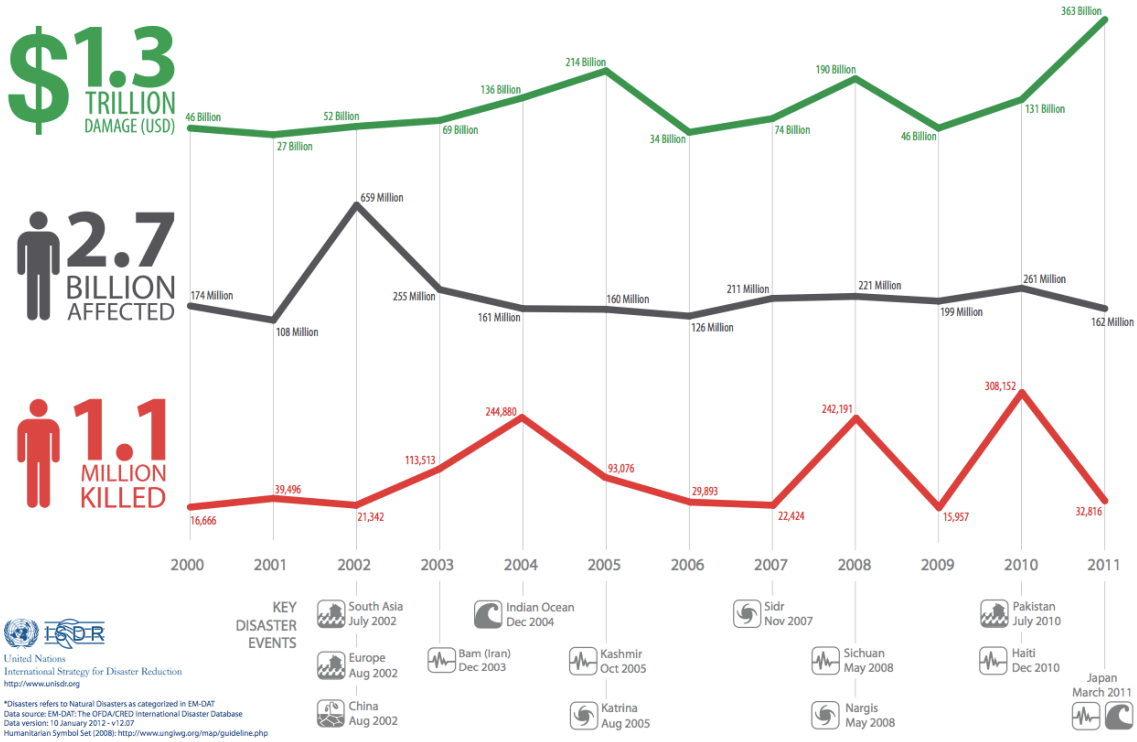

Figure 1 – Impacts of disasters 2000-2011 (Source: UNISDR on EM-DAT)

Hurricane Sandy, in the United States, was the most expensive natural disaster in 2012 with estimated economic damages of US$ 50.0 billion[4]. The continent most often hits by natural disaster over the last decade is Asia, followed by Americas and Europe, but all continents are strongly affected. For instance, in 2012, the 85% of geophysical reported damages were registered in the area of Ferrara, Italy, during the two earthquakes that hit the area.

A disaster can have many forms and can be categorized in many ways. The main distinction is made to the presumed cause: some result from force of nature; others from human action, and in some cases they can result from the combination of natural forces and human activities (Vale & Campanella, 2005). Always more human actions contribute to hazardous processes. Nature and society are interconnected at all scales and any change in one can potentially affect the other. In some cases a man-made disaster can have cascade effects also on the environment like in the case of the sinking of the Erika tanker off the coast of Brittany in 1999 that caused the release of thousands of tons of oil into the sea, devastating marine life. The fear of man-made disasters had changed since the Cold War, but especially after 11th September 2001 this risk perception is increased and the public attention to catastrophic terrorism is much more salient today than before (Birkland, 2004). Commonly, disasters are distinguished in two generic categories, natural and man-made.

In the same way, disasters can be characterized as rapid-onset disasters and slow-

[4] Hurricane Sandy was the second costliest storm of the decade. The first was Hurricane Katrina US$ 147 billion (CRED, 2013).

onset (or creeping) disasters (UNDP, 2004). The formers are instantaneous shocks – for examples flash-floods, volcanic eruptions, earthquakes, tsunamis, tornado – the latter, on the other hand, stand for many days, months or also years like droughts, climate change, desertification, soil erosion, and AIDS epidemic.

Natural disasters are generally classified into five major groups (CRED 2013) (see Figure 2):

1. Geophysical disasters: events originating from solid earth (E.g. earthquake, volcanic eruptions, landslide, avalanche and subsidence);
2. Meteorological disasters: events caused by short-lived (small to meso scale) atmospheric processes as in the spectrum from minutes to days like storm or hurricane;
3. Hydrological disasters: events caused by deviations in the normal water cycle and/or overflow of bodies of water caused by wind set-up (E.g. flood, flash-flood, wet mass movement);
4. Climatological disasters: events caused by long-lived/meso to macro scale processes as in the spectrum from intra-seasonal to multi-decadal climate variability (E.g. extreme temperature, drought, wildfire);
5. Biological disasters: disasters caused by the exposure of living organisms to germs and toxic substances (E.g. epidemic, insect infestation and animal stampede).

Similarity, man-made disasters are classified into two major groups (see Figure 2):

1. Technological disasters: disasters due to engineering failures, transport disasters, and environmental disasters (e.g. transport accidents, big fire, chemical contamination, nuclear accidents);
2. Sociological disasters: criminal acts, terroristic attacks, riots, war, stampedes, etc.

Type of Disaster	*Cause of Damage/Death*	*Example*
Natural Disasters		
Fire	Burning	Chicago, 1871
		London, 1666
Earthquake	Structural Collapse/Fire	S.F., 1906
		Tangshan, 1976
Flood/Tidal Wave	Drowning	Lisbon, 1755
Drought	Starvation	Nyala, Sudan, 2000
Volcano	Lava Flows	St. Pierre, 1902
		Pompeii, 79 A.D.
Hurricane/Typhoon	Illness/Collapse	Chittagong, 1970
Epidemic Disease	Illness	Plague, Mid-14th Century
Human Disasters		
Accidental		
Industrial Accidents/Sabotage	Poisoning	Bhopal, 1984
Nuclear Accidents	Radiation	Chernobyl, 1986
Deliberate, Place-Targeted		
Civil War	Bombing/Gunfire	Beirut, 1980s
	Arson	Atlanta, 1864
	Biological Weapons	
	Chemical Weapons	
International War	Bombing/Gunfire	World War I/World War II
	Nuclear Weapons	Hiroshima, 1945
	Biological Weapons	
	Chemical Weapons	
International Terrorism	Explosives	
	Hijacked Planes	WTC Attack, 2001
	Biological Weapons	
	Chemical Weapons	
	Nuclear Weapons	
Domestic Terrorist Campaign	Explosives	Okla. City, 1995
	Biological Weapons	
	Chemical Weapons	Halabja, Iraq, 1988
	Nuclear Weapons	
Riots/Civil Disturbances	Gunfire/Arson	U.S. Cities, 1960s
		L.A., 1992
Urban Renewal/Clearance	Displacement	U.S. Cities, 1950s/1960s

Figure 2 - Typology of disasters, damages and examples
(Source: Vale & Campanella, 2005 p.6)

Most disasters both natural and man-made can be considered as a consequence of development failure. In spite of the growing scientific knowledge and expertise about hazard and their mitigation, the human activities' pressure on ecological system is increasing with consequences on the territorial vulnerability. At the same time, the consequences of natural disasters affect the economic and social development because time and resources indispensable for remediation after a catastrophic event impair the stability and development of communities. These are called "secondary effects" and concern short- and long-term impacts of a disaster on the overall economy and socio-

economic condition (UNDP, 2004).

This also the reason why the power of a disaster is evaluated both according to the human and economic impacts. Human impact refers to the number of victims which comprehends both the number of people killed - included those confirmed dead and those missing and presumed dead – the people affected that require immediate assistance during the emergency and people reported injured or homeless. The economic impact of a disaster consists of direct and indirect consequences on the local economy. The shock of a severe disaster can create a cascade of disruption among interdependent systems that shatters the existing functional capacity of the area (Birkland, 2004). The direct consequences concern damage to infrastructure (electric power, communications, transportation, water, gas and sewage distribution) and building as well as damages to crops; indeed, indirect ones refer to market destabilization, unemployment, and the loss of revenues. Under these consequences, the operational capacity of a complex system - like a city - can have dysfunction and can be affected by new danger for the population. For instance, some types of disaster, as droughts or earthquakes, have impact over time and the return to normality needs years to be restored. Thus, disasters can aggravate other stresses such as a economic weakness, social/political conflicts, spreading of diseases, and environmental degradation (Jha, 2010). Social-economic consequences are a salient issue of post-disaster recovery due to the difficulty to overcome. In general, poor countries register greater human impacts, while economic impacts are felt more in rich countries.

Figure 3 shows a comparison between top 10 natural disasters in 2012 by numbers of victims and by economic damages. The former group is all composed by LDCs while the top 3 natural disasters by economic damages concern MDCs. But it is important to underline that if we compare the economic damages caused by natural disasters to the countries' Gross Domestic Product (GDP), the impact is higher and with more long-term consequences in poor countries (CRED, 2013).

Top 10 natural disasters by number of victims

Event	Country	Victims (in millions)
Flood, June	China P Rep	17.4
Flood, April	China P Rep	13.1
Flood, July-October	Nigeria	7.00
Tropical cyclone (Bopha), December	Philippines	6.2
Tropical cyclone (Haikui), August	China P Rep	6.0
Flood, June	Bangladesh	5.1
Flood, August-October	Pakistan	5.0
Flood, August	Philippines	4.5
Tropical cyclone (Damrey), August	China P Rep	3.8
Drought	Kenya	3.8
	Total	72.00

Top 10 natural disasters by economic damages

Event	Country	Damages (in 2012 US$ bn.)
Tropical cyclone (Sandy), October	United States	50.0
Drought, June	United States	20.0
Earthquakes, May[9]	Italy	15.8
Flood, July	China P Rep	8.0
Tornado, March	United States	5.0
Severe storm, April	United States	4.5
Severe storm, June	United States	4.0
Thunderstorm, May	United States	3.4
Flood, April	China P Rep	2.5
Flood, August	Pakistan	2.5
	Total	115.7

Figure 3 - Comparison between top 10 natural disasters in 2012 by numbers of victims and by economic damages [CRED, 2013]

In addiction to human and economic consequences, psychic injuries can be also profound. This impact is hard to measure since it is not necessarily proportional to the scale of a disaster and because trauma can persist long after the physical impact of a disaster. For instance, the trauma of 9/11 terrorist attacks hit all the Western World and enhanced the sense of fear and the risk perception (Vale & Campanella, 2005).

This thesis focuses mostly on geophysical and hydro-meteorological disasters. This approach derives from the need to limit the research field adequate to the aim of this work: namely, to investigate the role of knowledge in risk management and the consequence derived from the involvement of a increased number of actors and the consequent improvement of information flow. The myriad and diversity of actors involved during the different types of crisis do not allow a unique discussion. Each crisis has different actors involved according to the type of disaster, the spatial, temporal and jurisdictional extension; for these reasons it is not possible to talk of a unique methodology of action for natural disasters. However, part of the suggestions that will arise can be applied also to the others types of catastrophe, as for instance the multi-dimension of territorial resilience and the sharing of knowledge in order to improve the capability to manage the emergencies.

1.1.1. Protection and emergency

As already argued (see 1.1.) the understanding of hazards and disasters has changed through history (Smith, 2009). In the past, in cases where the sources of destruction were largely natural forces, people used to consider these as “acts of God”. This perspective emphasized the inevitability of catastrophic events because of the link to a divine punishment, rather than a consequence of the pressure of human activities on the earth. This fatalistic attitude implied that nothing could be done about the occurrence of disasters, thus not encouraging the development of knowledge to tackle them. The main

challenge in this field came out by the awareness of the terms hazard and risk and their linkage to human activities. The first big change took place in the Western Countries between 19th and 20th centuries with the development of science and the increased idea of disasters as *acts of nature*. However, the focus on *acts of nature* introduced some challenges, in particular brought to light the possibilities of working for the reduction of impacts of disasters - in particular through engineering measures – and with prevention actions (Quarantelli, 2000). Even if the first studies on human responsibilities in disaster started at beginning of 1900s, it took half a century to see disasters indirectly resulting from the *acts of society*. People used to involuntary create the necessary conditions for a hazard to generate a disaster, by building for instance non-earthquake proof buildings or urban area in flood plains. It would be incorrect to think that all the people consider disasters as *acts of society*, indeed planning for disaster is not too high on the attention agenda of citizens at large. The majority of the population does see civil protection as an expected responsibility of the government and does not feel responsibility in this field.

Otherwise, the majority of political authorities and governmental officials have accepted the view of modern society as main guilty party in the increase of disasters. There has been in the last decade a greater focus on this issue. Almost everywhere policies and programs are shaped in the light of "what could happen" and contemplate several options for taking action (including doing nothing), each of which is associated with potential positive or negative consequences (Renn, 1992, 2008). Indicative of this general trend was the proclamation by the United Nations (UN) of the 1990s as the *International Decade for Natural Disaster Reduction;* furthermore, in the Millennium Declaration, adopted in 2000, the UN notes the importance of reducing 'the number and effects of natural and man-made disasters' (UN, 2000 p.23). This effort put disasters on the attention's and action's agenda of many countries in the world, especially developing countries.

Nowadays the activities to prevent and tackle emergencies are mostly fulfilled by civil protection. The civil protection firstly developed from civil defence and rescue activities elaborated in the decades that followed and especially during World War II in many countries (Bignami, 2010) [5]. Civil protection is explicitly accepted as the major

[5] The history of the general evolution of civil defence is complex and has diverse historical dynamics in different countries, which however are not address in this thesis. Therefore, it could be useful for our purposes, to reassume the three major generalizations about the relationship between civil defence and civil protection activities and organizations argued by (Quarantelli, 2000):

- *In some instances, a civil defence emphasis at the* national *level has led to the emergence or development of* local *civil protection systems (…). (p.9)*
- *Civil defence systems have sometime been one of the multiple sources out of which civil protection has evolved, or currently still involve only one organization (…). (p.11)*
- *The involvement of the military in disasters is often independent of any existing civil protection or civil defence system. (…) (p.13)*

Even if there is much diversity and complexity in civil protection activities and organizations around the word, it is possible to identify some common tendencies. This topic will be deepen in Chapter 2.

governmental actor in risk management[6], in collaboration with environmental policies, spatial planning and social security. Indeed, it is less known that its role is not only restricted to the time of crisis but it concerns all the phases of a potential/real disaster, from prevision to recovery.

In this framework, it is important to specify the relation between risk, disaster and emergency management in order to avoid confusion. Thus, while there is often confusion on the meanings and overlap of terms, they are not identical (see Figure 4).

The term Risk Management concerns all kind of risk including industrial processes, financial portfolios, public health and safety. It includes also the voluntary risks that are hazards associated with activities that we decide to undertake, such as driving car, riding a motorbike or smoking cigarettes (Bignami, 2010; Smith, 2009)[7]. The voluntary risks do not only generate losses, but can also produce benefit (e.g. financial portfolio management).

Otherwise, emergency management is "*The organization and management of resources and responsibilities for dealing with all aspects of emergencies, in particularly preparedness, response and rehabilitation*" (UNISDR, 2004, p. 3). It concerns all types of collective risks. It is important to underline that emergency management can avoid the escalation of an event into a disaster or cascade scenarios.

Finally, the UNISDR, (2004) defined Disaster Risk management " *The systematic process of using administrative decisions, organization, operational skills and capacities to implement policies, strategies and coping capacities of the society and communities to lessen the impacts of natural hazards and related environmental and technological disasters. This comprises all forms of activities, including structural and non-structural measures to avoid (prevention) or to limit (mitigation and preparedness) adverse effects of hazards*" (ibid, p.3)

[6] A deeper definition of risk will be explored and explained in 1.1.3.

[7] The distinction between involuntary and voluntary risk is less clear than it appears. Most people react differently to voluntary risks according to the acceptable risk perception that they have. The acceptability of risk is often linked to the relative benefit.
"Acceptable risk is the degree of loss that is perceived by the community or relevant authorities to be tolerable when managing risk" (Smith, 2009, p. 52)

Figure 4 - Relation between Risk, Emergency and Disaster Management [Source: elaboration from Bignami, 2010]

1.1.2. The Risk Society

Risk management contains the concept of control, which presumes a decision-making process based on the idea that risk can be mapped and measured, so it could be generally controlled. Within this perspective of risk, planning from a positivist approach is the core of providing certainty; it plays an instrumental role to manage achieving that control. But from 1990s a new perspective of risk as unknowable or unpredictable has come to light. The contemporary society have to face risks as far ranging as degradation to the global ecology, international terrorism, global health pandemics, or the health consequences feared as a result of exposure to a myriad of technologies, chemicals, industrial toxins and pollutants and financial crisis (Jarvis, 2007).

In this context, Beck's thesis on 'risk society' - introduced in 1992 - has initiated some of the most interesting debates that challenge the social science tradition. These challenges regard the constructed nature of risk, which needs to go beyond the disciplinary boundaries to understand in which way particular risks are experienced, perceived, defined, mediated, legitimated and/or ignored.

In his work, Beck (1996) argued that the speeding up of modernization has produced a "watershed" between the world of quantifiable risk, in which decision-makers can think and act based on calculating risks, and the world of non-quantifiable insecurities that we are creating. The modern societies are confronted with the principles and limits of their own model. The western modernization and industrialization has increased complexity of risk in contemporary society. The concept of risk society takes this as its starting point, in order to articulate systemic and epochal transformation. In particular, there is a new challenge in the relationship of society to hazards and problems produced by it, with in turn exceed the basis of societal conceptions of security.

Beck's ideas of reflexive modernization, explain the "*self-confrontation with the consequences of risk society which cannot adequately be addressed and overcome in the system of industrial society*" (p.28). This turns traditional assumptions, about planning and managing the future, into inappropriate and overtaken by their failures to secure any calculable future (Adam, Beck and Van Loon 2000).

Above all, this transformation implies multiple uncertainties. In "*reflective of globalization*" theme, Beck (1992) explains that individuals become aware of the contradictions and limitations of the industrial society. There is not only a "reflexivity matters" but also "boundary" and "voice" matters (Cantelli, Kodate, & Krieger, 2010).

The boundary matters argue that the traditional categories of nation-state are not longer valid and the governance of uncertainty and risk involve various sectors and policy fields. The voice matters, indeed, concerns citizen participation and inclusion. Nowadays, new roles and identities for citizens, experts and bureaucrats have evolved and multiple types of knowledge beyond scientific expert knowledge have emerged and serve as on ongoing resonance body for risk perceptions and governance requirements.

In this framework characterized by uncertainty, the challenge is to find ways of relating risks to decisions and practices. Contemporary risks are unprecedented in terms of impacts and the possibility to be prevented. Beck emphasizes that risk implies decision-making, but in the face of unknown factor of crisis potential, decisions are increasingly disabled.

The emerging of new types of risk requires an alternative mode of planning practice that acknowledges the new conception of security to identify, enable and mobilize the physical, intellectual, social and cultural elements of society. Nowadays, in the context of a world with increasing uncertainty, there is the need of bringing a new dimension to the long-standing role of planning in risk management, by shifting the discussion from managing "calculated risks" to "uncalculated risks".

1.1.3. Risk and Vulnerability

As the previous sections showed (1.1 and 1.1.2.), it is impossible to live in a totally risk-free environment. Every day we face some degree of risk, some of these treats are "chronic", as pollution - and they need time to show their effects; other are "extreme" and have consequences (large-scale deaths and damages) that we call disasters.

The term hazard is rooted in the concept of change (Jha, 2010) and denotes a danger or a potentially harmful situation. Hazard is an intrinsic factor or a latent condition that has potential to damage, harm or create losses. According to UNISDR (2004) hazard is defined as " *A potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation*" (ibid, p.4) and it is associated with a level of risk and the degree of vulnerability of the system.

In the common acceptation, as well as in disaster management, the concept of risk refers to potential negative (undesirable) consequences that may arise from a future

event. In general, the definition of risk is the likelihood of an event's occurrence multiplied by the severity of the consequences of that event[8], if it occurs.

a) Risk (R) = Likelihood (L) * Consequence(C)

However, in disaster studies, the most commonly used formulation was defined by UNESCO in 1972. This definition establishes that risk is the combination of three components: Hazards (H), Vulnerability (V) and Exposure (E)

b) Risk (R) = (H) Hazard * (V) Vulnerability * (E) Exposure

(H)= the probability of occurrence of a potentially damaging phenomenon within a given time period and area.
(V)=the degree of loss to a given element or set of elements at risk resulting from the occurrence of a natural phenomenon of a given magnitude
(E)= Elements at risk: population, property and economic activity at risk in a given area

Thus, risk concerns the impacts (damages and human injuries and deaths) and it is linked to hazard and vulnerability. According to the research fields of application, several analysis methods are used. In the last decade there has been an acceleration in the use of a systemic or an all hazard approach, rather than setting up agent specific entities or functions (e.g. for floods or chemical threats). It has been recognized that a hazard *per se* in not a disaster but that a disaster is a social happening, where different elements can create cascade scenarios.

The growth of environmental and engineering sciences increased the research of structural responses to control the potential damages caused by natural events. By the end of nineteenth century, weather forecasting scientific tools and civil structures with defence scope had large diffusion since the main issue of scientific research was how to protect humans, their activities and buildings from damaging consequences. During this period the interactions between environmental hazards and human behaviour was underrated; only in the mid-twentieth century the behavioural paradigm started to be explored. The geographer Gilbert White (1945) introduced the social prospective to investigate the role of people in minimising risk. The literature related to the influence of human behaviour in 1970s contemplated a more radical alternative that focused on the differences between more developed countries (MDCs) and less developed countries (LDCs). This new paradigm put the development at the centre of its research, in order to investigate in which way a less developed economy contributes to vulnerability.

From the 1990s the emphasis on mutual interactions between nature and society grew; the complicated mix of interaction between human and natural systems increased the vulnerability, showing the complexity of disaster's causes. The complexity paradigm

[8] Consequence= expected loss in case of event

highlights the need of multi-disciplinarity in research activities. It also contributes to enlarge the focus from emergency's preparedness and response, towards strategies for mitigation and recovery.

Vulnerability conveys the idea of susceptibility to damage or harm (Eakin & Luers, 2006) and it can be seen as the capacity of a system to absorb or cope with the consequences of external effects. The aim of vulnerability reduction is to guide actions to enhance well-being through reduction of risk (Adger, 2006) .

According to the Intergovernmental Panel on Climate Change (IPCC, 2001), vulnerability is a function of the sensitivity of a system to change, its adaptive capacity and the degree of exposure of the system to hazard. It means that a system is vulnerable when is sensitive to modest changes, with harmful consequences.

Vulnerability is applied as a core concept in disaster management (Burton, Kates, & White, 1978; Smith, 2009; Wisner, 2004) as like in the study of climate change (Adger, 2000). During the years a variety of challenges have developed the vulnerability research, nonetheless this has conserved as key parameters "*the stress to which a system is exposed, its sensitivity and its adaptive capacity*" (Adger, 2006, p. 269). At the same time, vulnerability can take also into account more key factors as (Eakin & Luers, 2006):

- The interactions among stressors;
- The socioeconomic and biophysical framework;
- The role of equity and accessibility to resources;
- Nested scales and scalar dynamics of hazard.

Thus, it is possible to identify two types of vulnerability: territorial (physical) and systemic vulnerability. The former refers to spatial factors and characteristics. The latter, instead, is defined by the relational characteristics between human and natural systems.

Literature on vulnerability definitions and vulnerability assessment practice is characterized by a strong multidisciplinary approach, fragmentation and lack of dominant paradigms. Eakin & Luers (2006) outlined three intellectual lineages:

1. Risk-Hazard (RH) model: studies focus on risk/hazard mitigation in which vulnerability is equated with the analysis of stressors and the potential impacts;
2. Pressure and Release model (PAR): researches in the political-economic and political-ecological fields, characterized by an idea of vulnerability and adaptive capacity dependent on conditions such as accessibility and fairness in the distribution of opportunities and resources;
3. Recent literature focuses on the topic of ecological resilience, in which risk and vulnerability are interpreted as dynamic properties of a system, whose social and environmental dimensions are constantly changing.

The risk-hazard model has evolved from the natural hazard literature in geography; the main focuses are the identification of external events and the location where they may occur and the socio-economical consequences that might be expected (Cutter & Finch, 2008; McCarthy, Canziani, Leary, Dokken, & White, 2001). In this model, vulnerability is a function of exposure to the hazardous event and the sensitivity of the entity exposed

(Turner et al., 2003) – conditions that make people or places vulnerable to hazard. In this approach the evaluation of vulnerability is an ex post identification and it works from hazard to impacts (see Figure 5).

The limits of this model are the lack of the ways in which the systems in question amplify or attenuate the impacts of the hazard and the role of social structure and institutions in managing exposure and consequences (Turner et al., 2003).

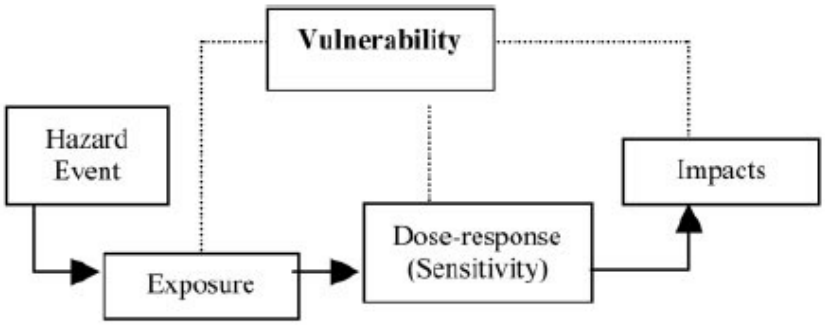

Figure 5 - RH framework. Chain sequence begins with hazard; concept of vulnerability commonly implicit as noted by dotted lines. [Source: Turner et al., 2003, p. 8075]

In the political-economical approach (PAR) the analysis of social, economical, political, cultural and biophysical factors are the basis to understand the exposure to risk and the adaptation ability to unforeseen consequences (Pelling, 1999; Rose & Liao, 2005). Risk is explicitly defined as a function of the perturbation, stressor and vulnerability of the exposed entities. It is characterized by the interaction of scales of causation and the social differences (Eakin & Luers, 2006) and by the emphasis on historical processes. The model identifies three components on the social side: root causes, dynamic pressures and unsafe conditions and one component on the natural side, the natural hazard itself. The inequities in resource access and opportunities, the social marginalization and the institutional framework are the causes of the state of vulnerability: positive or negative challenges in these fields have impacts on vulnerability (see Figure 6). The limit is that, despite the emphasis placed on "social" conditions of exposure[9], the PAR model does not take enough into account the vulnerability of biophysical subsystems (Wisner, 2004).

[9] In this model the livelihood can be defined by drawing upon and combining five types of "capital" (Wisner, 2004, p. 96):

1. Human capital (skills, knowledge, health and energy);
2. Social capital (networks, groups, institutions);
3. Physical capital (infrastructure, technology and equipment);
4. Financial capital (savings, credit);
5. Natural capital (natural resources, land, water, fauna and flora).

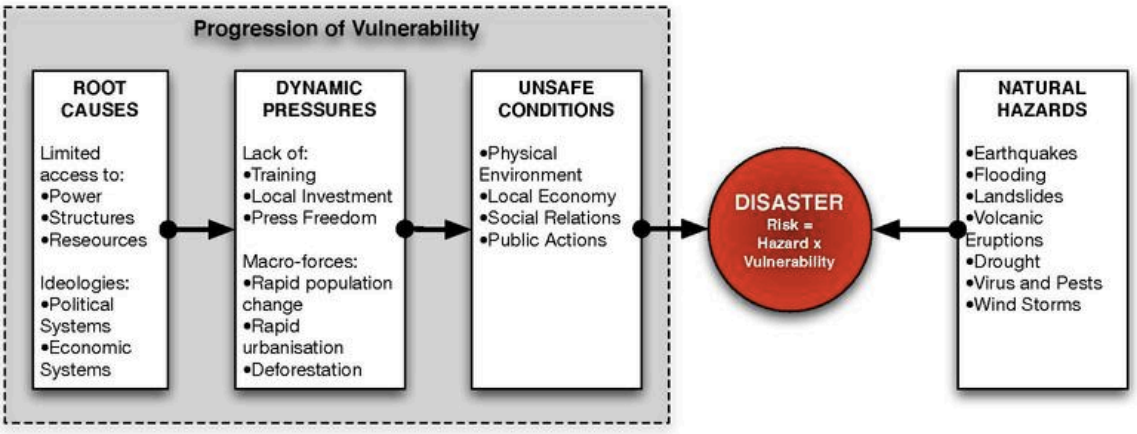

Figure 6 - Pressure and Release (PAR) model.
The diagram shows the progression of vulnerability.
[Source: Wilsner, 2004, p.51]

The latter intellectual lineage considers vulnerability as a dynamic property of a system where human and ecological systems have a continuous interaction. The resilience paradigm was firstly defined by Holling (1973) and focuses on the evolutionary trajectories of a system according to its ability to absorb changes and disturbances. Resilience theory was firstly applied to ecological system, than to the social sciences. In this framework vulnerability concerns also social organization and the human managed resource systems. In this literature lineage, resilience and vulnerability have their point of contact in the need to change the response of systems and actors. Their potential convergence and learning comes from the consistent focus on social-ecological systems[10] where human actions are integrated in natural systems, with mutual influences.

Despite the traditional negative conception of vulnerability – the susceptibility to be harmed –, the term resilience emphasizes the capability to absorb disturbances as well as the capacity to self-organise and to evolve in a new stable-state (Adger, 2006). The IPCC definition of vulnerability highlights the lack of ability to adapt of a vulnerable system rather than a resilient one that is less sensitive to changes and has the capacity to adapt.

Otherwise, other authors like Turner et al. (2003) argued that vulnerability concerns the totality of the system that consists of:

- The components of exposure;
- The human-environment condition of the system that determinates its sensitivity to any set of exposures;
- Coping, impacts, adjustments, and adaptations. These elements are scale dependent and interactive.

[10] See BOX 1 – System theories: from General System Theory to Social-Ecological System

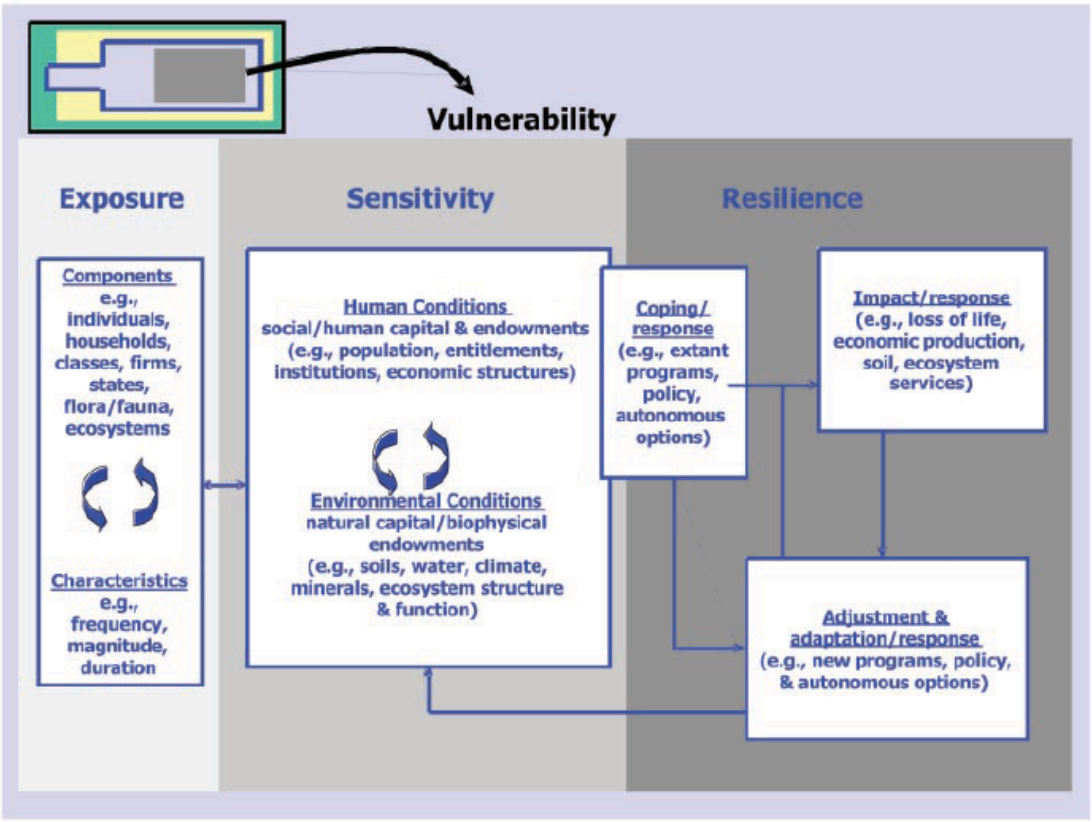

Figure 7 – Details of the exposure, sensitivity, and resilience components of the vulnerability framework
[Source: Turner et al., 2003, p. 8077]

The framework illustrates the complexity and interactions involved in vulnerability analysis. In particular, it highlights its attention to factors and linkages that potentially affect the vulnerability of the human-ecological system in a place.

1.2. Resilience: an emerging concept in planning

A great challenge decision makers are facing today is how to satisfy society's needs, especially in the fear of a disaster. Citizens rely increasingly on the authorities to mitigate their insecurities. In this framework, the emerging of the 'resilience' concept, signals a turn in disaster risk reduction planning because it takes into account the myriad of variables that affect complex systems and introduce the question of responsibilities. The social risk thesis of Beck (1992) argued the current ineffective responses of institutions to the intensity of risks. In his view, the concept of "public reflexivity" shows the enlargement of responsibility for risks from institutions to all individuals.

The following paragraphs analyse how resilience has been used in prior research across different disciplines. The purpose is to illustrate the range of definitions deployed in different research contexts, by demonstrating the range of issues resilience can be applied to.

The concept of resilience was first formulated in ecology during 1960s, but it has influenced many other research fields, firstly, in physical sciences than in economics, phycology, anthropology, human geography and other social sciences (Folke, 2006). With the concept of social-ecological resilience (F. Berkes & Folke, 1998; Folke, 2006; Walker, Holling, Carpenter, & Kinzig, 2004), the resilience theory has been influenced also planning theory and practice, with new explorations and paradigms (Davoudi et al., 2012).

Over the past decade, its use has increased with the growing of uncertainties and complexity of urban system. In particular, building resilience has become a "pillar" of disaster management, climate adaptation, regional economic development and strategic planning (Davoudi et al., 2013).

As Davoudi (2012) highlighted, the diffusion of "resilience thinking" is in danger of becoming a fuzzy concept because of the multiple meanings of resilience that have since emerged. This chapter aims to develop a conceptual framework for assessing the resilience-building claims in planning. It will, firstly, trace the origin of resilience concept and analyse its three fundamentally different meanings; secondly, it will present how resilience is linked with risk and vulnerability, and finally outline the resilience interpretative approach to emergencies management asserted in this work.

1.2.1. Engineering and ecological approaches

As already mentioned in the previous paragraph, the concept of resilience was borrowed from ecological studies, deriving it from the manner in which ecological systems cope with stresses and disturbances caused by external factors. From the ecological prospective resilience is evolved in the studies on the adaptive complex systems (see Box 1.1).

The Canadian theoretical ecologist, Crawford Stanley Holling, was the father of "resilience thinking" (Davoudi, 2013). The roots of resilience perspective can be found in his studies of population and behavioural ecology. He was the first to introduce the

importance of nonlinear dynamics and defined resilience as "*the persistence of relationships within a system is a measure of the ability of these systems to absorb changes of state variables, driving variables, and parameters, and still persist*" (Holling, 1973, pag. 17).

Despite, in his studies, Holling drew a distinction between stability and resilience. He stated that stability is "*the ability of a system to return to an equilibrium state after a temporary disturbance*" (Holling, 1973, p.17). In this form – named engineering resilience - conceptual emphasis is focused on "resistance" and stability and is related to the magnitude of the disturbance (Adger, 2000; Coaffee, Wood, Rogers, e NetLibrary, 2009). Thus, engineering resilience refers to the ability of a system to return to an equilibrium state after a disturbance. This implies that the fastest the system bounces back, the more resilient it is (Davoudi et al., 2012).

In contrast to engineering resilience and stability, Holling understood resilience in term of size of stability domains, or more meaningfully, as the ability to absorb and adapt to a disturbance, that is not necessarily the capacity to return to a steady-state. This is called ecological resilience (Adger, 2000; Holling, 1996; Walker et al., 2004). This definition rejects the existence of a single equilibrium and instead suggests that there are multiple equilibria. In other words, ecological resilience is "*the capacity of a system to undergo disturbance and maintain its functions and controls*" (Gunderson & Holling, 2002; Gunderson, Allen, e Holling, 2009;), or the buffer capacity to "persist" to an external disturbance (Folke, 2006).

Thus, while engineering resilience focuses on efficiency of function and vicinity of a stable equilibrium, ecological resilience focuses on maintaining existence of function and multiple equilibria (Holling in Davoudi et al., 2012; Folke, 2006). The engineering resilience applies only to behaviour of a linear system, where resistance to change is addressed in term of recovery. In reality, disturbance events and spatial heterogeneity cause recovery trajectory impossible to predict and the system is never the same but it is continuously developing (Folke, 2006).

For this reason, the concept of alternative stable states and the ecological resilience perspective began to influence all fields linked to complex system and non-linear dynamics and became the theoretical foundation for the work with active adaptive ecosystem management (Folke, 2006).

A complex system is an open system and because of the second law of thermodynamics, it can change its entropy. This mutation is determined by non-linear interactions between its elements. It means that the interactions in complex system can generate reactions unintuitive and apparently accidental (Bertuglia & Staricco, 2000) . In complex systems, the change of an element can spring braking reactions (negative feedback), or reinforce reactions that amplify the initial change (positive feedback).

The no-linear interaction means that a local action could have an impact on the whole system. This means that the system has a complex behaviour "oriented to stability" and every time the system overshoots the steady-state produces a "dynamic reaction"; after that "*the system may look similar but it is not the same system, because like any living system*

it is continuously developing" (Folke, 2006, p. 257). The result is a continuous process of mutual adaptation and self-organization of the components that characterizes both biological as socio-economic systems.

Thus, resilience is not only about resisting disturbance and change, to conserve what you have, but includes also all the opportunities that disturbance opens up in terms of re-organization and evolution of the structures and processes (Folke, 2006).

An example is the forest fires. They can play an important role in forest ecosystems because they could regulate the underbrush, avoiding more destructive fires. It means that the system has a self-organization by fires at low temperatures able to clean undergrowth without damaging the older trees. In this case, self-organization improves the ability to respond to external stress and adaptation towards uncertainty and risk (Bertuglia & Staricco, 2000).

Nevertheless, the idea that the nature of the stability domain does not remain fixed over time was introduced by the socio-ecological approach (see Box 1.1) to resilience (Scheffer, 2009) with the aim to include in ecosystems analysis the social sphere (Brunetta & Baglione, 2013) .

BOX 1 – System theories: from General System Theory to Social-Ecological System

The biologist Ludwig von Bertalanffy in 1930s formulated the "General System Theory" (GST) relevant for numerous fields of research. The theory argues that a system is a set of elements that have inter-relationships so that the understanding of the essential properties of the parts of a system comes from an understanding of their relations. In this first phase, the model referred only to isolated systems based on the second law of thermodynamics. Later, in 1969, von Bertalanffy contributed to the system theory with his theory of "Open Systems" in which the interactions are into or out of the system boundary. Unlike an isolated system that contains limited energies, an open system is influenced also by external events that can alter the energy amount. In the beginning, the open systems theory was applied only to natural sciences, before that the concept has its applications also in social sciences. The von Bertalanffy's work was continued by others groups in particular related to the Santa Fe Institute, through the notion of complex systems (Bertuglia & Staricco, 2000). The complexity of the systems refers to the multiple non-linear interactions and feedback loop and casual chain relations that link system components. It means that phenomena have multiple and dispersed causes that cannot be solved only through scientific solution organized on traditional disciplinary lines (Berkes, Colding, & Folke, 2003). The complexity is related to the system behaviour that is oriented to stability but that can reach multipla equilibria. Non-linear interactions between its elements mean that most of them are unpredictable and unintuitive and when conditions change there can be positive or negative feedbacks. Through the elements interaction, the systems can self-organize, novel configurations can

emerge, and adaptation is made possible. This means that a disturbance can create the challenge for new opportunities for recovering or reorganizing (Resilience Alliance, 2010). This capacity is related to the maintenance of the diversity and individuality of its components and the localized interactions among those components. A complex adaptive system has four basic properties: aggregation, non-linearity, diversity, and flows (Folke, 2006).

Natural systems and social systems are complex adaptive systems in themselves. The Nobel Prize winning chemist, Paul Crutzen (2002) argued that nowadays is impossible to understand nature without society and vice versa (Jahn, Becker, Keil, & Schramm, 2009) and theorized the idea of a new geological epoch called *Anthropocene*. This means that the human impact on the ecological system has increased the human-nature relations so that there is an emerging new consensus on the origin of problems based on the concept of the social-ecological systems, in order to emphasize the integrated concept of humans-in-nature. The social-ecological systems theory represented the revolution to a new mode of research based on transdisciplinary that nowadays is the main challenge in scientific research. Multi- inter- and transdisciplinary researches have been recognised as frontier field and a fundamental objective of EU research policy by the European Commission (2005). Since the fifth Framework Programme, the EU cross-disciplinary objective claims to overcome the traditional structure of research organisations based on sectorial research communities.

Nowadays social-ecological systems are the core cognitive interest of different fields of research in particular for sustainable development. Different research fields refer to SES theory: geography has described social-ecological systems at multiple spatial scales (Egner & Von Elverfeldt, 2009). In the social sciences this theory was applied to analyse the transformation of social structure.

Central to resilience theory is the concept of a social-ecological system because natural resource management issues is the sum of multiple ecological and social integrated elements. A SES is the combination of ecological, cultural, political, social, economic, technological components.

Social-ecological systems are complex and adaptive and delimited by spatial or functional boundaries. SES theory was defined the "integration of the parts" (Glaser, Krause, Ratter, & Welp, 2008; Holling, 1996) and its main important tendencies are:

1. The evolutionary ecological orientation, focusing on adaptive renewal cycles in multi-scale, panarchical structures;
2. Complexity theory, focusing on non-linear dynamic systems and the transfer of system expertise to strategic planning and adaptive management;
3. Quantitative/formal approaches.

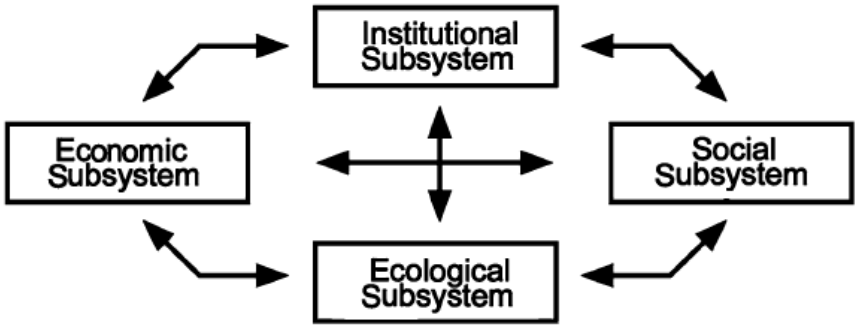

Figure 8 - Socio-ecological system
[Source: scientific Planning Committee of IRG Project Science Plan 2010]

In social-ecological systems, the over-exploitation of natural resources, increased urbanization and climate change underline the human/nature relations as a growing problem (Glaser et al., 2008).
As already discussed, systems can change and may shift into a different state; this transition can be slow and gradual but also sudden. Understanding how a system change over time and which are the critical thresholds can potentially provide advance warning or changes for avoiding undesirable shifts in system states. Thus, resilience can represents the distance between a system state and a critical threshold.

1.1.2. Social-ecological approach

In the social-ecological approach the concept of resilience means adaptation, learning and self-organization in addition to the ability to resist to the disturbances.

Social–ecological resilience argues that "*social and ecological systems are themselves linked (…) to synergistic and co-evolutionary relationships*" (Adger, 2000, p. 350). This means to understand how ecosystems are structured and behave and how institutions and the people associated with them are organized and act. In the volume ''Barrier and Bridges to the Renewal of Ecosystems and Institutions'' (Gunderson, Holling, & Light, 1995) it is argued that social-ecological resilience is linked to the necessity to learn to manage by change, rather than simply react to it as well as individuals and small groups or teams of individuals play a key role in this context (Folke, 2006; Folke et al., 2010).

In summary, according to C. Folke (2006) and Gotts (2007), the social-ecological resilience conceptual framework includes:

1. Multipla equilibria: Rather than a single equilibrium point, complex systems generally have multiple metastable regimes;
2. The disturbance: *" (…) the magnitude of disturbance that can be absorbed before the system changes its structure by changing the variable and process that control behaviour"* (Gunderson & Holling, 2002 p.4);
3. Multiple distinctive scales with cross-scale interactions. (Gunderson & Holling, 2002) argue that systems form a multilevel hierarchical structure with different

degree of self-organization.

Resilience concepts	Characteristics	Focus on	Context
Engineering resilience	Return time, efficiency	Recovery, constancy	Vicinity of a stable equilibrium
Ecological/ecosystem resilience	Buffer capacity, withstand shock, maintain function	Persistence, robustness	Multiple equilibria, stability
Social-ecological resiliece	Interplay disturbance and reorganization, sustaining and developing	Adaptive capacity, transformability, learning, innovation	Integrated system feedback, cross-scale dynamic interactions

Table 1 - Classification of resilience (Folke, 2006)

Therefore, social –ecological resilience is not as "a return to normalcy" (Pendall et al., 2010, p. 76) but as the ability of complex social-ecological systems to change, adapt or transform in response to stresses and strains (Carpenter et al 2005). For example, the strong shock caused by hurricane Katrina in New Orleans in 2005, has not only caused severe damages and losses to the system but also revealed a number of conditions as unsustainable. The shock was likely to create the need to reformulate a "new order" in terms of society, economy and policies.

The multiple distinctive scales with cross-scale interactions is described by Gunderson & Holling (2002) with the concept of "*panarchy*"[11], preferred to the idea of hierarchy. Panarchy describes the cyclical and organizational attitude of systems: how an ecosystem organizes itself and how it changes and responds to external disturbances and to changes in the world. With the term panarchy, Holling (2004) described the way living systems both persist and innovate at the same time and show how fast or slow, events and processes can transform ecosystems in a evolutionary way giving changes for learning to their societies.

With the metaphor of the "adaptive cycle" (Figure 9), Gunderson e Holling (2002) suggest that complex systems follow a four-phase cycle of (1) "growth" or "exploration" (r); (2)"conservation" (k); (3) "release" or "creative destruction" (omega) and (4) "reorganization" (alpha). Each phase of the cycle creates the condition for the next phase and every phase entails the loss of resilience and the consequent vulnerability of the system. The cycle is composed by two phases of growth – called forward loop - and two phases of reorganization (back loop).

[11] The term Panarchy firstly coined by Paul Emile de Puydt in 1860, referring to a specific form of inclusive, universal system of governance that includes all other forms of governance. Panarchy with this acceptation is used in international relations to describe global governance (Edson, 2010). At a later stage, the term Panarchy was introduced in systems theory. Holling and Gunderson referred the term to the mythological figure of Greek god Pan, the paradoxical spirit of nature. They joined the idea of Pan to the dynamic reality of hierarchies across scales and to the interactions among them that can influence the phase cycles of one another (Holling, 2004). In systems theory the term was coined as an antithesis to the word hierarchy in order to describe the framework of nature's rules.

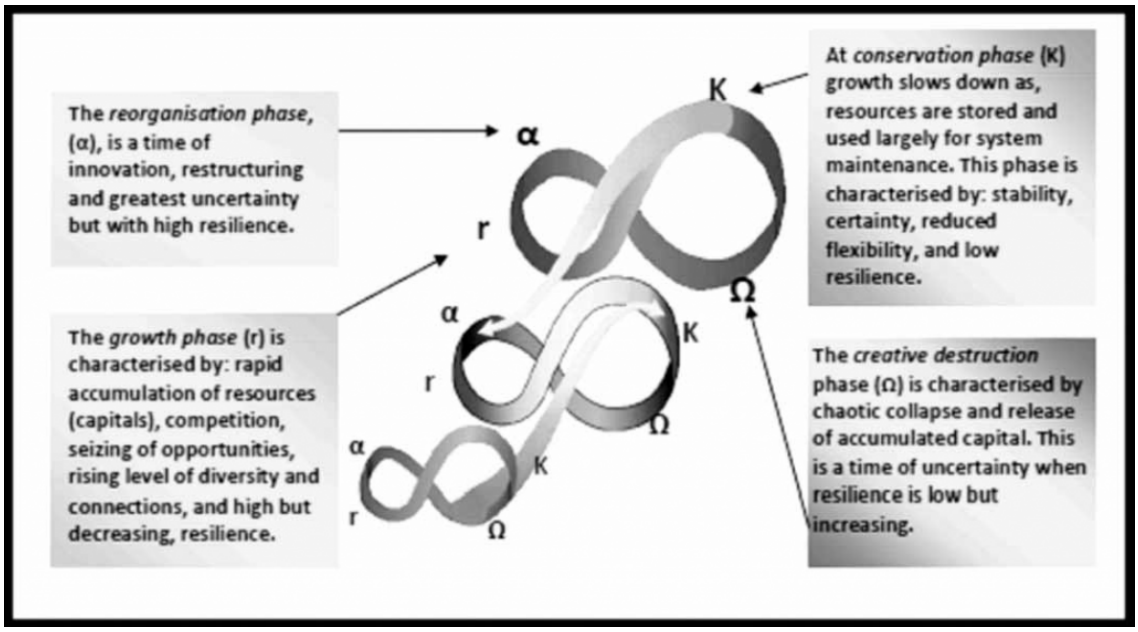

Figure 9 – Panarchy, a holistic model of nested adaptive cycles emphasizing cross scale interplay (Gunderson e Holling, 2002)

Therefore, the adaptive cycle focuses the attention on processes and dynamics function rather than primarily on states and structure (Pickett, Cadenasso, & Grove, 2004). Thus, adaptive cycles and their interactions are not limited to the dynamics of ecosystems, but they similarly occur in societies. This means that individuals, societies, groups, and institutions play a strong role in many ecosystems. Frequently, the influence is in the form of past activities that have a persistent effect on soils, plants, or other major components of ecological systems. Figure 9 shows a stylized representation of the four system steps and the flow of events among them. The connections between the different levels of panarchy explain how also small and fast cycles can affect larger and slower ones (revolt) or when large and slow ones can control the renewal of smaller and faster ones (memory). External events can start unpredictable reactions. During such times, uncertainty is high and control is weakened, but it does not mean that the results will be a collapse of a part of the system. Indeed, the cross-scale interactions can create space for innovation and reorganization that means there are opportunities for change and evolution of the system. This concept enlarged the application of panarchy as a framework for different research fields. Panarchy and adaptive cycles are also applied in policy and institution (Ostrom, 1990), economic geography (Simmie & Martin, 2010), decision making (Westley, 1995) and knowledge systems (Berkes & Folke, 1998). If we look to complex natural systems we can easily find a front-loop phase of slow, incremental growth and accumulation that is more predictable and a back-loop stage of rapid reorganization leading to renewal or to collapse characterized by a higher uncertainty (Holling, 2004). The instability can be part of a process of transformation that can lead to a new phase of opportunity. For a better understanding of cross-scale interactions and their consequences we can look to Arab Spring. The revolutionary wave of demonstrations, riots and civil wars is creating change

not only at national levels. Since protests began, the flows of immigrants to Europe have changed and economic consequences have been registered by the geopolitical instability in countries of oil mining.

The idea of a system in transformation has been also interpreted with an evolutionary perspective in planning by Davoudi et al., (2012a). In this meaning, the emphasis is not on the return to normality but - on the contrary – is on the research of a new normality (Davoudi et al., 2012; Pendall et al., 2010).

1.2.3 Connecting resilience concept to planning

Historically, planning is open to absorb new concepts and translate them into its theories and practices (Davoudi et al., 2012). Several terminologies, approaches and metaphors have been rapidly becoming part of planning theories and practices, some of them with solid roots others with uncritical acceptance. Also resilience is not an exception.

During the last decade, as discussed in the previous part, the concept of resilience has increased its scope. Resilience has emerged as a fusion of ideas from multidisciplinary traditions e.g. ecosystem, engineering infrastructure, psychology, behavioural sciences and disaster risk reduction. The multiple concepts and approaches to resilience have been widespread in a wide range of research fields also thanks to its fuzzy character. As Keith Shaw highlights "*much of the appeal of the term lies in it being sufficiently malleable*" (ibid., 2012b, p.308) which makes it a "*versatile umbrella term*" (Fünfgeld & McEvoy, 2012, p.326). It stands to reason that the current context characterized by crisis, uncertainty, complexity and interdependencies may be easily interpreted by resilience approach that "*appears to have the potential to play a critical role*" (Teigão dos Santos & Partidário, 2011).

However, several authors have grounds to fear that resilience could be the buzzword of the moment, replacing others commonly used terminologies as sustainability and adaptation (Davoudi et al., 2013; Porter & Davoudi, 2012; Teigão dos Santos & Partidário, 2011). In order to frame the concept of resilience it is therefore important to analyse its relationship with sustainability and adaptation and its implications.

Sustainability and sustainable development were born as concept in 1987 (UNWCED 1987), indicating the capability to "*ensure the needs of the present without compromising the ability of future generations to meet their own needs*" and, they rapidly, became the most relevant keywords of political action of the contemporary society. The success of sustainability in the past two decades overwhelmed most research fields, from economy to ecology to the idea of sustainable development as an oxymoron to underline the need of a sustainable de-growth.

Sustainable development focuses on the future and, as Teigão dos Santos and Partidário (2011) argued, it could be considered as a precautionary principle that turn its attention to avoid negative consequences of nowadays development in the world of tomorrow. In the same way, the two authors underlined the current increase of instability, crises and pressures on ecosystems that needs new and rapid solutions, in a

more adaptive way, due to their stronger and faster cascading effects. Therefore, resilience offers something in reaction to the uncertainty and insecurity of contemporary context (Shaw, 2012).

In this framework, resilience, reflecting the capacity of a system to absorb disturbance and to reorganize itself without collapsing, appears to be a key condition to effectively pursue a sustainable development (Lebel et al. in Teigão dos Santos & Partidário, 2011). Somehow, resilience could be considered as included in the concept of sustainability, where sustainability is the ability to maintain the functionality of the system when it is disturbed.

Specifically, resilience and its cross-scale interaction play a fundamental role in managing a transition towards more sustainable development. Several authors (Gunderson & Holling, 2002; Lambin, 2005) recognized that the organizational attitude of the systems in the resilience approach is a fundamental issue of sustainability. In an uncertain and unpredictable reality, looking at social-ecological systems through the lens of resilience enables the consideration of a world where the capacity of its multi-stakeholders (such as scientists, policy-makers, practitioners, private entrepreneurs and citizens) interaction across scales is fundamental in determining the dynamics of the system. Thus resilience implies a change in the way of doing policy, planning and governance, it provides a common language across different sectors and discipline (Wilkinson, 2012). Resilience implies different assumptions and approaches, meaning a change in processes that go from being essentially rationalist, reactionary or bureaucratic, to becoming more adaptable, anticipative, flexible, collaborative and co-accountable.

In the same way, the new issues that emerge from resilience approach to sustainable development appear also in relation to adaptation concept. Indeed, translate into the context of climate change, adaptation can be explained as vulnerability, exposure, sensitivity, adaptive capacity, but also resilience. Commonly, adaptation to climate change refers to engineering resilience concept. Similarly, when climate change adaptation examines a species' or habitat's vulnerability, ecological resilience approach seems most appropriate and can provide a framework for identifying critical thresholds (Fünfgeld & McEvoy, 2012). However, it underlines an understanding of adaptation as a process that involves and enhances social learning, institutional change and innovation.

Traditionally, the goal of risk mitigation is the protection of people, of properties and of the environment from the destructive force of catastrophic events. Nevertheless, building a resilient city does not only concern the use of land and structural engineering. It must also provide the capability to anticipate and respond to disasters. Static engineering-based conceptualization of resilience has been embraced for long time by disaster studies and the focus has been on recovery in quantitative terms. On the contrary, the metaphor of social-ecological resilience helps to synthesize the integration between ecology and social sciences due to the central role of human ecosystem framework in multiple scale (Teigão dos Santos & Partidário, 2011). According to the main definitions, we could identify three characteristics that allow the use of social-ecological resilience concept for urban systems:

- Humans are part of the ecosystems. "*human ecosystem framework are not a matter of humans versus nature, but humans and ecological processes combined into a reciprocally interactive network*" (Pickett et al., 2004)
- Complex system. Urban system is the sum of several subsystems in interaction.
- Adaptive cycles. The ecological, social and economic processes permit the continued adjustment and self-organization of urban systems.

Thus, in the planning process, resilience highlights the need to be more flexible. It considers transformation as normal, and dynamism as an intrinsic factor of how systems act. For this reason, it appears a deep affinity with governance theory and social learning, co-management and participation.

As Godschalk (2003) argued *"a resilient city is a sustainable network of physical systems and human communities"* (ibid., p.137). In this metaphor, the physical systems are the constructed and natural environmental components of the city, whereas human communities concern all the actors that live, work and act in that space. The physical systems include the structural engineering like roads network, energy facilities or infrastructure and building, as well as its natural systems as topography, geology and soils. For Godschalk, the physical system is the body of the city, its bones, arteries, and muscles. This means that during a disaster the physical systems must work in order to guarantee a proper and effective functioning under extreme stresses, otherwise without a persistent and resilient physical system a city will be extremely vulnerable to disasters.

In the same way, a body without a brain directing its activities, responding to its needs, and learning from its experience is likewise fragile and vulnerable. The metaphor of the brain refers to the human communities with the social and institutional components of the city. "*They include the formal and informal, stable and ad hoc human associations, that operate in an urban area: schools, neighbourhoods, agencies, organisations, enterprises, task forces, and the like. (...) During a disaster, the community networks must be able to survive and function under extreme and unique conditions.*" (ibid., p.137)

Thus, social and institutional networks have varying degrees of organisation, identity and cohesion. During a disaster they must be able to handle the emergency. Their absence or inefficiency undermines the capability to find solutions.

If we take on Beck's notion of public reflexivity in risk society it could be very close to the meaning of resilience (Sapontzaki 2007). Despite the growing interest among the politicians, and practitioners to use community resilience as a mean of confronting the response to local disasters (McAslan, 2010), resilience remains a difficult concept to practice, thus achieving a tangible outcome is challenging compared, for instance, with the risk management concept (Mitchell & Harris, 2012).

Nowadays most of actions in this context are focused only on making the system physical resistant to disaster force (Godschalk, 2003), but there are not enough programs for community preparedness, forecasting and warning (Pearce, 2003). If community's resilience will be improved, it would be more responsible for building ultimate urban resilience.

The key challenge should be built in knowledge, learning ability and adaptation of institutions that manage ecosystems at the different levels, in order to improve the resilience of natural and human systems and to contrast their vulnerability in the present context of uncertainty.

The adaptive cycle – as defined as in Holling's definition – concerns the characteristics of being a systemic process of complex environmental systems, characterized by high levels of uncertainty, and affected by potential ecological social and economic impacts, due to different management options. This process is continually improving its management skills, learning and adapting constantly[12]. The ability to learn is related to the cyclical approach that manages the effects of policies and/or actions and includes the results in subsequent decisions with the integration of different knowledge. One useful outcome of resilience method is exactly the ability to link together phenomena that in mainstream planning approaches still remain firmly separated.

In this view, it draws an alternative theoretical perspective of planning more dynamic, fluid and interpretive, that requires a shift of methodology from "command-and-control" to "learn-and-adapt" (Davoudi et al., 2013). For this purpose planning as learning is fundamental to align ideas and goals, to shape leaderships and achieve a shared vision instead of acting as a bureaucratic process (Teigão dos Santos and Partidário 2011)[13].

In this framework, stakeholders must create new relationships to enhance multidirectional information flows to learn from each other and to develop together flexible ways of managing their environments. In the same way, planning also as communication is crucial to enhance information flows and to build relationships. Planning should be a process of communication with its regulations, orientations and actions, but in reality the information display at the end of the planning process, often disregards the different capacities and needs of the potential end-users.

Therefore planning for resilience could be considered as a more perspective to foster adaptive capacities. The different stakeholders as well as the citizens and the decision-makers are central in this process.

In this research, social-ecological resilience is defined, hence, as the social capacity to respond to disturbances and changes. The analysis is oriented to organizational and institutional dynamics underling ecosystem management, too.

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[12] Pickett, Cadenasso e Grove (2004) use the concept *learning loop* to define the need of long term dialog among different institutions and community in order to ensure the monitoring and implementation of knowledge.

[13] Teigão dos Santos and Partidário identified four different characteristics that planning processes should adopt in order to be resilience: anticipation, innovation, learning and communication.

a) Planning as anticipation is important to perceive emergent disturbances and to identify early signals and possible solutions.
b) Planning as innovation is needed to be more flexible and dynamic in generating better solutions, instead of repetitive processes.
c) Planning as learning is fundamental to knowledge, to produce consensus and co-accountability.
d) Planning as communication is decisive to raise consciousness, to bring support and built relationships.

2.RESPONDING TO DISASTERS

Emergency management is affected by a deep complexity in terms of uncertainty, number of stakeholders involved, extension in space and time and potential damages.

Since the response to emergency started to be more organized, there is as there was, persistent problems regarding coordination and communication. It must be said that over the last 20 years, there has been several improvements and it is possible to find several emergency management cases of success[14]. Nevertheless, "*the management responses to disasters in general, have not matched the considerably better preparedness planning that has been undertaken*"(Quarantelli, 2000, pag. 18).

Managing an emergency means identifying and framing the crisis, taking decisions under pressure, organizing individuals and sources, but also improving crisis management skills from one crisis to the next, as well as studying and working in order to avoid or mitigate new crises (Koraeus, 2008). Furthermore, it also means being able to manage the cross-scale data, information and knowledge among the myriad of actors involved in each step, from prevention and prediction to recovery. For all these reasons there is the need to create a stronger relationship among different actors[15]. As Folke (2006) argued, the biggest change in this context must be built in knowledge and learning capacities of institutions and organisations. Social and institutional networks have different degrees of organisation (Cash et al., 2006), thus, during disasters they must be able to handle the emergency. Their absence or inefficiency undermines the capability to find solutions. As Beck declared *"Risks always depend on decisions"* (1996, p. 30) because taking decisions can transform uncertainty and hazard into risks. In the same way, decisions depend on data, information and knowledge, that means that in complex systems decisions depend on flows of information and networks.

Nowadays, there is a problem of lack of coordination between policies and actors with competence for risk management, i.e., civil protection, rescue services, spatial planning and sectorial planning. The difficulties in close and smooth cooperation reduce the effectiveness of actions. One of the hardest obstacles to overcome in this field is the gap in understanding that tend to separate distinct professions with different training and background. These exist between most professional areas, but can be exemplified by the following relationships (Lindberg & Sundelius, 2012):

- Between security and safety professionals;
- Between different civil authorities;
- Between public authorities and private sector;
- Between levels of authorities;
- Among individuals.

[14] For successful cases see Quarantelli (2000) and Wenger (1998)

[15] Also European Communities (2009) put " linking the different actors throughout the disaster cycle" as a key issue in the Commission's point of view. The environmental issue is maybe the first one that integrates the multidisciplinary approach as the only way to find long-lasting solutions.

All these groups have in common the necessity to cooperate and coordinate, before, during and after a catastrophic event. Some key factors contributing to the misunderstanding and to the lack of or inefficient cooperation are rooted in the different terminologies, ways of organizing and finally in the procurements of sector-specific technological solutions that each category has. Not surprisingly, they have problems in understanding each other's and the way their sectors/competences interact (Costanza, Wainger, & Folke, 1993).

The second part of the thesis aims to define the theoretical part concerning the contemporary structure of risk management and the role of knowledge and in planning. The questions of this part are: *Which are the areas of action and at what level in order to strengthen safety? Which is the role of knowledge planning?*

2.1. Disconnected policies and actors

Institutions are not autonomous entities: not only their units are interdependent but they have consequences and are conditioned or upset by external factors. Following this premise, institutions cannot be analysed as close systems: they are open systems, interdependent with their environment.

According to Costanza, Wainger, & Folke (1993) mismanagement of risk can be caused or by missing or failed institutions, or by scales mismatches among institutions. The latter can be related to ineffective connections between scales or because decisions are based on information aggregated at the wrong scale. Nowadays, emergency management is organised by different agencies at diverse levels, sometimes acting on their own and sometime establishing partnerships, whether formal or informal (Godschalk, 2003). In order to analyse the mismanagement of risk towards actors' coordination is important to understand how many different institutions and agencies are involved in the different phases and how they interact.

Nowadays most of the activities are fulfilled by civil protection. At the European level, the EU Civil Protection legislation was revised at the end of 2013 to increase the security of EU citizens through pre-planned and effective manners to respond to the natural and man-made disasters. The new legislation places more emphasis on disaster prevention, risk management and disaster preparedness. It asks the Member States to share a summary of their risk assessments and to refine their risk management planning as well as to share the best practices (ECHO, 2014).

In general in EU, the primary responsibility for dealing with disaster lies with the country in which occurs. But when the scale of emergency overwhelms national response capabilities, the EU Civil Protection Mechanism enables a coordinated assistance from the participating States.

Each country has own legislation on risk management and civil protection. However, most of the countries are based on the principle of vertical subsidiarity within the institutional level of power. At the same time, there is also horizontal interaction within the public and the private sector as well as the inclusion of volunteer organisations.

As already argued, the activities to prevent and tackle emergencies are mostly fulfilled by civil protection. In general, at the national level, usually the relevant activity is quartered in a formal governmental agency mostly with policy and programmatic directive responsibilities. At the other levels, the civil protection arrangements are very heterogeneous, mostly complex and with problems of integration between higher and lower levels. Meanwhile the lower governmental levels are the most important social actors[16], with the support of external civil protection groups composed in majority by semi-volunteers.

[16] In most of the countries there is an evolution to a de-centralized civil protection system (especially in Europe where the subsidiarity has had great influence), but there are still very centralized national level systems such as in Japan.

Even if a more detailed explanation of the Italian and Swedish legislations will be provided within the cases study of this work, it is useful to provide some brief information regarding the frameworks of the countries analysed in the cases study, in order to give the reader a good working basis.

In Sweden the government is responsible for establishing guidelines for policy according to the decisions of the Swedish National Assembly, Riksdag. Regarding emergencies, the Ministry of Defence and the Ministry of Sustainable Development are the two ministries with more responsibilities[17]. The Ministry of Defence is responsible for prevention, preparedness and civil defence (response phase), while, the Ministry of Sustainable Development is responsible for housing issues and planning (prevention and prevision). Government decisions are implemented at central government agency level. This is a peculiarity of the Swedish system that has ministries very small supported by a second layer of central administration constituted by about 300 central government agencies and state-owned companies. Some the agencies are the Swedish Road Administration, the National Board of Housing, Building and Planning, the National Board of Health and Welfare, the National Insurance Board, the Swedish Rescue Services Agency, the Swedish Emergency Management Agency, the Swedish Consumer Agency and the National Institute of public Health. However, the Swedish system has a decentralised architecture characterized by large autonomy of municipalities and county councils that have the operative responsibilities.

Regarding Italy, the reform process of de-centralization has begun a few years ago with the objective of giving more relevance, authority and responsibilities to regional and local institutions. Despite most of European Countries, Italian civil protection is a task that involves the entire State organization, both at a national and territorial level including also the civilian society through voluntary organisations. The reasons of this choice lies both in the decentralisation reform as well as to the specific territorial context such as the Italian one, which presents a range of possible risks unknown to other European countries. In this framework, Regions and local administrations are increasing their responsibilities n land planning, housing, and civil protection. The first person responsible for civil protection is the Mayor, who organises municipal resources according to pre-established plans. The Mayor should also be the point of contact with the structural planning concerning land use and housing regulation. However, the system is based on the principle of subsidiarity and in case of necessity the support of Provinces, of Regions and the assistance of peripheral State administrations, will be guaranteed and co-ordinated by the Prefects. In the same way, all the competent authorities at the different levels are included in all the activities.

Even if in most of the cases the civil protection legislation used to provide a very strict division of responsibilities, governance has become one of the main tools to address

[17] Other Ministries are involved like the Ministry of Industry, Employment and Communications , that is responsible for traffic safety and the Ministry of Health and Social Affairs, that is responsible for health and social care.

complex and multi-faceted issues like emergency management. The simplest definition of the term "governance" refers to the network relationships and partnership arrangements among several actors, representing different sectors and levels of government that come together to address a common goal, to combine resources, to share decision making (Kapucu, 2012).

2.1.1. The Prevision-Prevention-Response-Recovery chain

The impacts of extreme natural events concern multiple stressors, temporal, spatial and jurisdictional scales with the involvement of an enormous number of divers actors with different values, levels of knowledge and practice (Adger, 2006; McEvoy, Fünfgeld, & Bosomworth, 2013). For example, most of effects caused by a flood are local but the driving social-economic as well as ecological forces, appear on all levels and cross scales [18] (Hahn, 2003). The activities included in hazard management are several and each of them could be considered as different step of a unique cycle that covers from the prevision phase to recovery activities (Smith, 2009). All the steps are consequential and each of them is crucial for the best emergency resolution. We can consider three distinct times: *before*, *during* and *after* the event. At beginning there is the ordinary time, during which actors are involved in activities aimed to avoid or mitigate the possibility of an emergency situation, or however, to be prepared to deal with it. During emergency, we speak of the "golden" hours, referring to the ones immediately before and after and emergency relief operations. Finally, after a catastrophic event there is the time dedicated to the activities necessary to return to normality. Each of these three times

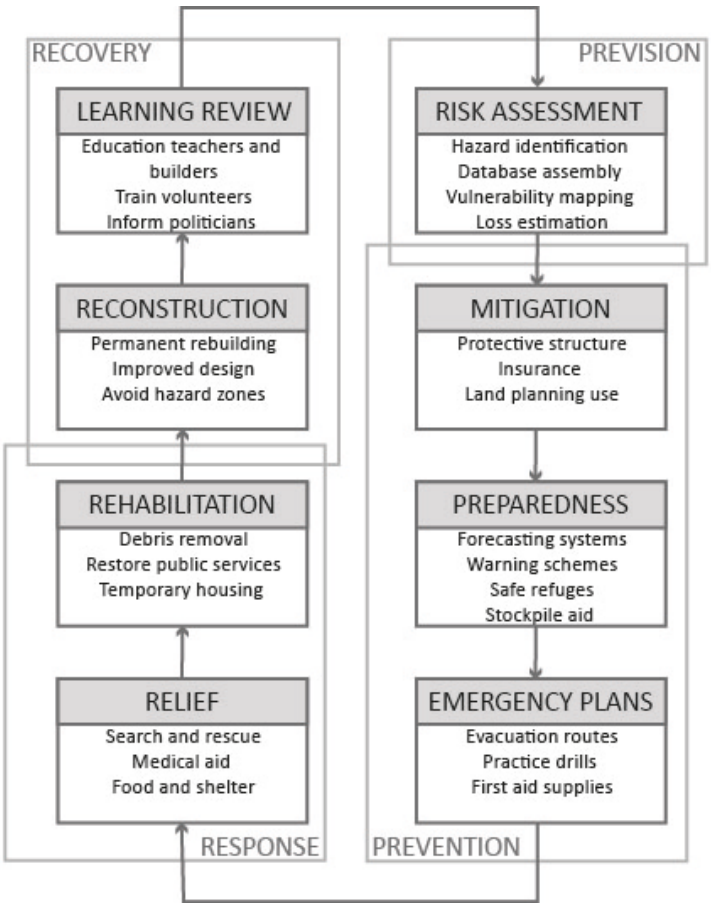

Figure 10 - The PPRR-chain and its activities [personal elaboration from Smith, 2009]

[18] See 2.1.3

could be divided in different phases that together constituted the PPRR (prevision-prevention- response – recovery) chain (see Figure 10):

"Before" the event

- Prevision: activities for identification of risks and areas affected by them. They concern the collection and elaboration of data and the study of different possible scenario. This is the phase of risk assessment when different professional competences, according to the risk to analyse, work on the identification of the elements that compose the hazard and vulnerability of a specific area. Usually, during this stage the competent authorities are the Departments and Agencies of Environment, Infrastructure, Housing and Planning and Civil Protection at diverse levels.
- Prevention: all the activities aimed to reduce or avoid the possibility of damage. Usually they are land-use planning, otherwise they could be engineering works. Prevention also concerns preparedness activities such as hazard warning and emergency plans to manage in the best way a contingent emergency (evacuation procedures plus the stockpiling of supplies).

During these steps, the actors - using the morphological, environmental social and administrative knowledge of the territory concerning the multi-risks that could affect the jurisdictional area - work on vulnerability and exposure modification of the territory. Another important task before the event is the community preparedness that concerns education and information activities especially to children in the schools. In most of the cases these activities concern "what to do" during the emergency (safe refuges during earthquakes or floods and escape routes) rather than mitigation actions. The local authorities are the main responsible for this phase because of their land use and structural planning role. Other actors are involved like fire fighters, Health Department and volunteers groups. In Italy the emergencies plans are made at local level with the supervision of Regional level.

During the event

- Response: reaction activities to ensure people affected by the events. It concerns the rescue of survivors and the distribution of basic supplies (food, water, medical care). The emergency response depends on the magnitude of disaster and the degree of cascade effect, but it also relates on the capacity flow of resources, equipment information and knowledge among the actors involved (Comfort, Ko, & Zagorecki, 2004).

In general, the main actors during this step are the fire fighters – if the event is considered not critical – otherwise, civil protection, specific police forces (e.g. forest service in case of forest fire events), volunteer services and/or even military defence, in case of disaster, are involved. The coordination during this phase should not be limited to the horizontal interaction among the forces involved, but it should also affect the competent authorities of previous steps of prevision and prevention.

After the event

- Recovery: from the rehab, first activities destined to re-enable the fundamental functions (e.g. removal of debris, reactivation of power and water supplies as well as

infrastructure), to the reconstruction, long-term actions to return an area to "normality" after devastation. This phase does not concern only physical activities but include also psychological counselling to community.

Ideally, the reconstruction step should also be a moment for a learning review taking into account the feedback loop in order to include the past experience in subsequent decisions. The recovery stage should apply the methodology of "learn-and-adapt" for building a dynamic planning (Davoudi et al., 2013) in which the different stages of the PPRR-chain are part of a continuous adaptive cycle. According to social-ecological resilience concept, in fact, the reconstruction could represent the "reorganization" phase of the adaptive cycle when it is possible to change and transform the unsustainable previous conditions that had co-determined the break of the system.

The PPRR chain shows that hazards and disasters are two sides of the same coin: they are inextricably linked (Smith, 2009). Usually the framework for risk management is set by government regulation operating at local, regional, national and even international levels. As Smith argues (2009) *"(…) effective risk resolution depends on the implementation of a sequential series of actions. The individual stages often overlap but it is crucial that they operate as a closed loop in order to draw benefits from experience and feedback."* (ibid, p. 67).

The management of risks is usually entrusted to a variety of institutions that operate on different spatial scales. As the phases, also the responsibilities and competences of the different institutions involved overlap. Nowadays, even if there is a progressive awareness of the need of feedback and collaboration among the different actors of all phases, a fully integrated approach to disaster reduction is rarely achieved. However the multilevel government and governance is affected by the coordination dilemma. The negative aspects in coordinating several actors at multiple levels lie in institutional weakness, administrative fuss, fragmentation, or lack of technical expertise.

In order to ensure an effective collaboration among competent bodies, it is necessary a co-planning system capable to integrate the different expertise in a shared system. A better knowledge management could be an important tool to deal with emergencies. The concept of adaptive cycle considers knowledge and practice like two key elements in the process of continuously improving of management skills and adaptation. But cooperation is not only a problem of governance: a cooperation without information is not sufficient to increase response effectiveness (Comfort et al., 2004).

In the practice, problems do not present themselves as givens but they require a sum of different knowledge coming from the professional pluralism that characterizes all the PPRR-chain. The elements built up the knowledge are influenced by the actors made them. But different environments generate different types of knowledge at different levels. Thus, this method does not take into consideration the degree of understanding of the diverse actors without a common conceptual space for the different domains

What emerges is a cross-scale claim characterized by the interaction of scale and level in the knowledge system. The term "knowledge" refers to the process of interpreting and

understanding of data that should support actors in taking the right decisions (0). In the next section, the importance of scaling problem and the consequences on knowledge creation and use will be explored.

2.1.2. The framework of responsibilities and institutions

In social-ecological systems (SESs) all cultural, political, social, ecological, technological and other components interact at multiple levels (Resilience Alliance, 2010). The two subsystems (ecological and social) can be viewed as composed of spectrum of interconnected exogenous, slow, and fast variable with a direct impact on the people (Chapin et al., 2006). According to Anderies, Janssen, & Ostrom (2004) several entities are involved in social-ecological systems interaction: resources (territory), resources users (citizens), public infrastructure providers (institutions), public infrastructure (engineering works and social capital), institutional rules and external environment (weather, economy, political system) (see Figure 11). The system elements' evolution has different speeds but the system approach is holistic because it does not focus on a detailed understanding of parts, but on how key components contribute to the dynamics of the whole system. Through these interactions, social-ecological systems can self-organize, new configurations can emerge and adaptation is made possible. This is the reason why SESs are suitable for a resilience assessment because of their capacity to self-recover or self-reorganize following a disturbance.

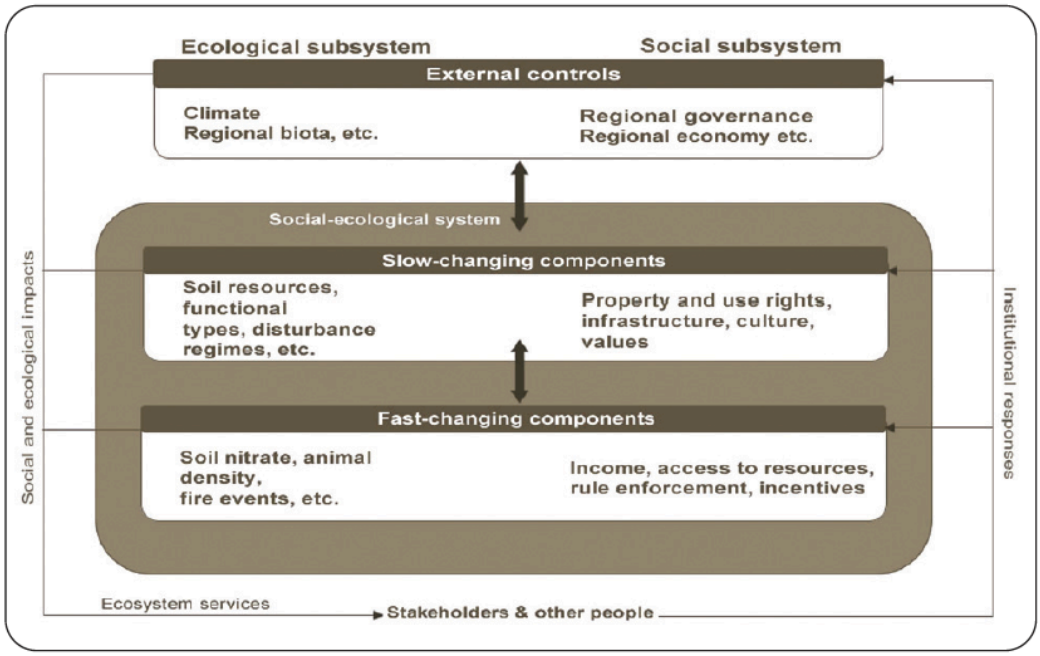

Figure 11 - Conceptual model of an integrated social-ecological system [Resilience Alliance, 2009, p.6]

People respond to social, environmental, and ecological changes of the system through a complex web of institutions[19], which in turn affect slow and fast variables of the system. Institutions involve multiple sectors and scales and the interactions among these actors; organizations and rules determine how people make decisions, and exercise responsibility. In a resilient approach the main aim of institutions should be the protection and the well-being of the community, which is achieved by controlling use of lands and organizing and directing the social behaviour. Understanding institutions' behaviour and interactions is therefore fundamental to understanding social-ecological interactions in SES and reorganize them in order to find more sustainable development and increase the system resilience. The institutional configurations to the changes of the systems concerns several and different type of actors and tools and depending on the structure of the social system governing and managing the SES. Following Chapin et al. (2006) it is possible to recognize different categories of institutions that directly or indirectly affect ecosystems:

i. Resource-harvest institutions: sectorial actors focused mainly on the management of goods (e.g. agriculture, forest, water, ect). They usually include regulatory tools;
ii. Resource-conservation institutions: govern choices to conserve and protect ecosystem. The focus is long-term conditions.
iii. Hazard-reduction institutions: govern choices that reduce the societal impacts of natural hazards.
iv. Ecological externality-producing institutions: heterogeneous social economic sectors pursuing development goals. These institutions have indirect effects on ecosystem (industrial activities, construction of infrastructure).

Management and governance process among different institutions can be difficult to be achieved in practice because problems do not present themselves as given and institutions have different perspective in recognizing and solving them (Schön, 1983). Thus, to address contemporary environmental problems, it is therefore important to understand how barriers to collaboration can be overcome.

Public management of risk is usually a multi-discipline and multi-sector policy field characterized by disconnected actors from civil protection to sectorial and spatial planning. The coordination is not only a inter-sector issue but it involves different jurisdictional, institutional and temporal scales among the different stages of PPRR chain (Bignami, 2010; Sapountzaki et al., 2011; Wilbanks, 2006). The number and type of actors involved concern the type of disaster (e.g. forest fire, earthquake, floods, landslide, etc), the spatial extension and the type of damages on people and goods. In most of the countries the risk management is entrusted to a variety of institutions, which operate on

[19] In literature on resilience and SES the term "institutions" concerns both formal and informal ones. Formal institutions are codified rules such as constitutions, law, and property rights. On the other hand, informal institutions include social and behavioural norms typical of a specific community. In this part of the thesis most of attention is on formal institutions and the way they cooperate together. Informal institutions will be explored later, with a focus on the possibility to promote a collaborative behaviour in risk situation including citizens during emergencies.

different spatial scales, from national to local level, covering the different stages of the PPRR chain (see Table 2)[20]. Some actors work during all stages of PPRR, others are involved only in few of them. In the same way, some institutions are directly involved in the crisis (e.g. emergency management activities) others indirectly effect the pressure and consequently the vulnerability of the territory (e.g. territorial strategic development).

Actors/Agencies		Prevision	Prevention	Response	Recovery
National government		X		X	X
Civil Protection department		X	X	X	X
Regional Level	Special Department (Forestry, Water Management Authority, Health and Environment Agency)	X	X		X
Local Level	Municipalities (Department of Housing and Spatial Planning, Environment, Transport)	X	X	X	X
	Fire- fighters		X	X	

Table 2 - The actors involved in the phases of the risk/disaster cycle [own elaboration]

The proof of this complex situation characterized by the overlap of responsibilities is demonstrated by the overall lack of a cohesive policy which would have the capacity of providing a suite of strategies that could be integrated to address the consequences of large directional chances. In reality, the PPRR chain - which should be based on the continuity and the circularity of risk management activities (as already showed in figure 10) - has as result situations where the respective information, knowledge and policy actions run in parallel without any linkages, feedback, and mutual interaction. In general, lack of coordination can damage the effective and efficient capability to deal risk (before) and crisis (later) with measures and funding contrasting and duplicated. Nevertheless, it does not mean that all the PPRR-chain is characterized by malfunctions, but in most of the cases the ability in coordination is linked to the individuals' will rather than to the procedures and tools.

The analysis of the governance and of the network among institutions can provide a clearer understanding of the role of power dynamics and conflicts between stakeholders and their ability either to promote or to undermine the resilience of the system (Resilience

[20] The table "The actors involved in the phases of the risk/disaster cycle" exemplifying the structure of risk management competencies in Europe. In reality, European countries have their own authorities and legislation according to the principles of their own constitution. What is important to underline is that both top-down or bottom-up structure of policy making involve several actors with interscale and transcale interactions.

Alliance, 2010). The characteristics of institutions' network can influence system dynamics and management outcomes. Obviously there is no optimal structure but different network characteristics can facilitate or impede different processes such as information sharing and collaboration opportunities. In analysing network is important the number of relations between actors, the degree of centrality of actors within the network, the existence of cohesive subgroups and their degree of isolation (Resilience Alliance, 2010).

2.1.3. The cross –scale claim[21]

This thesis follows Gibson et al. (2000) definitions of scale and level since they are meant to be applicable to the research aim. They defined scales as "*the spatial, temporal, quantitative, or analytical dimensions used to measure phenomenon*", and "levels" as the units of analysis that are located along a scale.

Commonly, levels have a spatial feature - e.g. small, medium or large-size phenomena – but they could be also related to time (durations, frequencies or effects). Closely related to spatial scale are jurisdictional scale defined as clearly bounded and organized political units. In the same way, jurisdictional characteristics are linked to institutional arrangements that also have fitting inner hierarchy (Cash et al., 2006). Following the classification of hierarchy defined by Gibson et al. (2000) there are two types of hierarchy: inclusive and constitutive where inclusive refers to levels with no cross-interaction and organization, whereas, constitutive hierarchy adverts to levels that can interact as in a complex system. In such systems, phenomena occurring at any one level are affected by mechanisms occurring both at the same level as by levels below and above[22]. Thus, it is fundamental to examine complex systems and their disturbances from a multilevel perspective because they depend on understanding the constraints at all levels. As previously argued, also resilience underlines the complex web of interrelations and feedbacks that often contains as well as the discontinuities (Gibson et al., 2000).

It comes to light how the scaling problems can be related to issues of scale and/or level as well as to hierarchies and players involved. Most attention given to scale in studies of human-environment interactions has focused on spatial, temporal and jurisdictional issues, but there are also some issues not conventionally framed as a scale problem, but that have to do with the "scale" of management response and change (Cash et al., 2006; Kok & Veldkamp, 2011). Following Cash et al. (2006) one of the issues in relation with scale could be the problem of "*knowledge as a scale*".

In wider terms, knowledge could be defined as "*a system of progressive embedding"* (Koraeus, 2008) of data and information. It means that data that are created at different

[21] In this research the term "cross-scale" refers to interactions across different scales, for example, between spatial domains and jurisdictions. Changes in cross-scale may arise from consequences of interactions or be caused by other variable. (Cash et al., 2006).

[22] It was the Panarchy theory of Gunderson and Holling (2002) to add to Hierarchy theory the concept that all levels are considered as influencing each-other in a top-down and bottom-up hierarchy.

scales and levels are linked by a cross-level interaction in order to support decisions.

For example, many environmental management plans and actions can be grouped into hierarchical sets ranging. Thus, each phase of the risk management chain has to combine data and models at different spatial and temporal scales, or also to extrapolate information between scales and levels. The schematic illustration on scales and levels realised by Cash et al. (see Figure 12) shows how fuzzy and, at the same time, complex is the definition of knowledge in relation to the level of the analysis. It is difficult to identify the scales of knowledge but it is undeniable that knowledge has to do with scale. For instance, "*a focus on a single geographic scale tends to emphasize processes operating at that scale, information collected at that scale, and parties influential at that scale – raising the possibility of misunderstanding cause and effect by missing the relevance of processes that operate at a different scale"*(Wilbanks & Kates, 1999, p. 608)

In building knowledge, there could be different types of interaction between the owner of the data or information and the last user. In reality, these interactions are characterized by a lack of data, limits in gathering data at multiple levels and lack of cross-level interaction (Gibson et al., 2000) rather than by a "progressive embedding".

The next section of this work explains how all these processes have been tackled in practice by most of the governance literature, but have been also improved by the application of information technology even if without adequate feedback and learning.

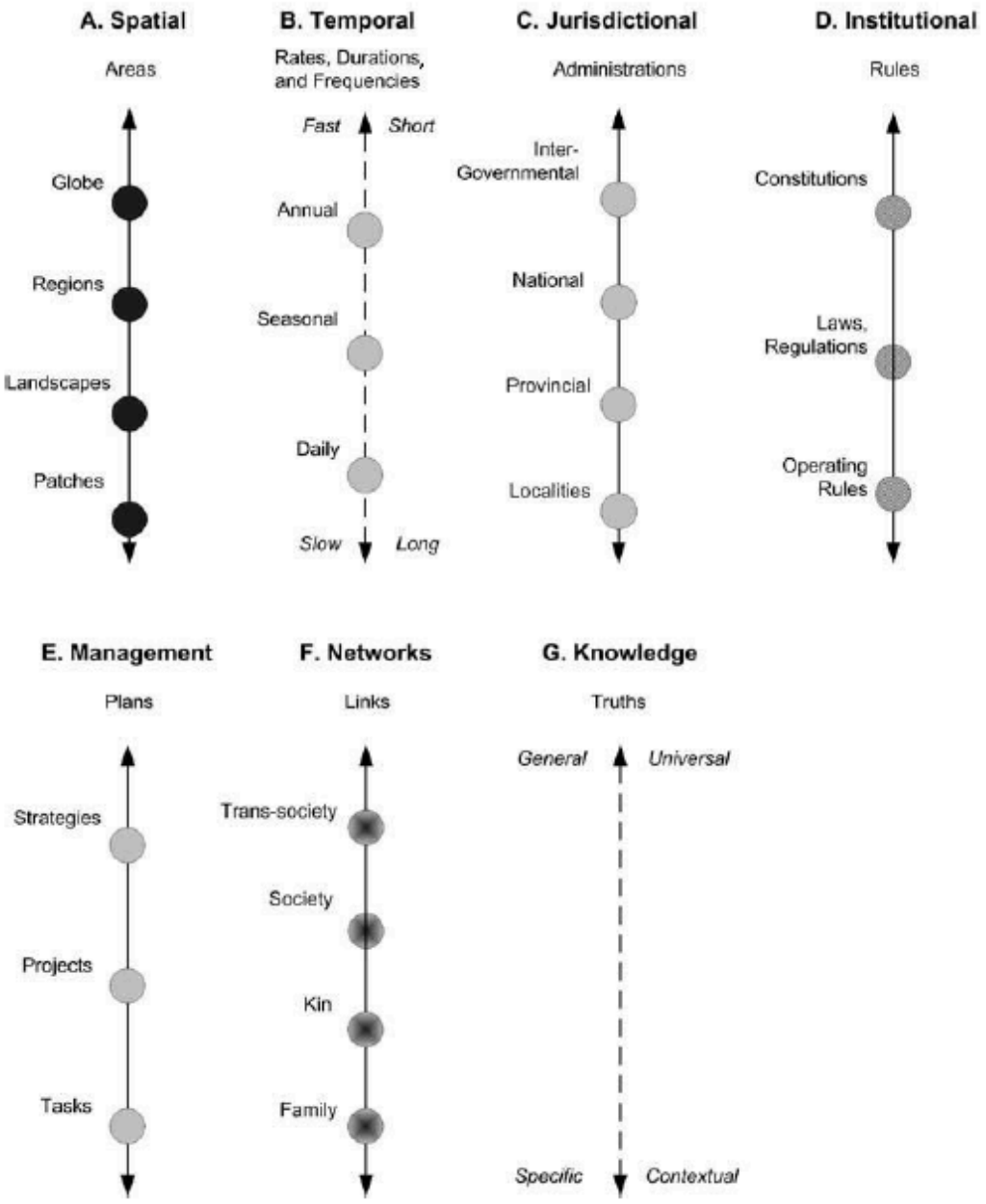

Figure 12 - Schematic illustration of different scales and levels that are critical in understanding and responding to human-environment interactions [Cash et al., 2006]

In its history, planning theory has always made own terms as multiscale and multilevel to indicate the presence of more than one level or scale. The planning theory has often referred to interdisciplinary but with low attention in implying that there are important cross level or cross-scale interaction. The cross-level and scale interaction emerges especially from planning practice in which different policies overlap on the same territory in different times. The organizational attitude of the system is crucial for resilience and this attitude is directly linked to the capacity of system's multi-stakeholders to interact across scale. Governing ecological-social problems means coming to terms with cross-

scale and cross-level dynamics (Buizer, Arts, & Kok, 2011; Cash et al., 2006). A hot spot of the social ecological system (SES) literature is the management of them, in particular referring to adaptive management. As Buizer et al. (2011) explained "*rather than focusing on discovering reality, attention is shifted to developing methods that could facilitate the analysis of complex SESs*" (ibid, p. 5).

Over the years, several methods have been studied to understand stakeholders' behaviour in the management system (e.g. multiagent simulation; social network analyses; system dynamic models) and a range of participatory tools and methods have been employed.

Following Buizer et al. (2011) all these works acknowledge the idea that scales and levels must be considered as co-produced in processes where institutions work together. In this field planning theories and practices have a long history in including stakeholders linked to various mode of governance across temporal-spatial scale: multilevel or multiscale governance of problems and the corresponding need to address these problems to multiple administrative levels as well as public-private relationship (Kok & Veldkamp, 2011; Termeer, Dewulf, & Lieshout, 2010). Thus, scale is not a new subject in planning, actually it has always had a key role in the entire literature on the governance of social-ecological systems and consequently on social-ecological resilience (Termeer et al., 2010). However, the growth of sustainability issues and the increase of claims like climate change, natural disasters, pollution and biodiversity ask solutions, now more than ever, that stretch across traditional jurisdictions.

Kok & Veldkamp (2011) define governance as a mode of governing where there has been a shift from government to governance characterised by less hierarchy between governing levels. In the literature related to scale and governance there is a promising common ground for further collaboration and integration of scale and governance, not only among scientists, but with policy makers and relevant shareholders, or citizens as well. Otherwise practical solutions are fuzzy in this field. As Kok & Veldkamp (2011) noticed there seems to be two separate communities in scale-related research: one analysing the role of temporal and jurisdictional scales with a strong spatial starting point, and the other operating on the role of networks and information flows released from spatial issue.

Despite all commonalities on description of the state of the art, analysis and conceptual issues, that concretely proposed solutions differ considerably. Some authors focus their attention more on communication claims others on the norms that could allow evaluating the multilevel governance effectiveness. In this thesis governing problems concern not only problems that arise when the level of public goods do not correspond with the territorial boundaries of governmental authorities; but they include also the lack of horizontal and vertical interplay of the knowledge between authorities. In doing so, the scaling problem focuses more on the knowledge issue not interpreted as the recognition and discussion of knowledge claims (Buizer et al. 2011) but more related to the cross-scale knowledge sharing and interaction. This approach to cross-level claim does not entail only attention to typical spatial and jurisdictional issues of risk management but

also to the knowledge and network scales.

Planning witnesses an increasingly involvement of "knowledge developing" actors, such as experts and practitioners, policy maker, citizens, professionals and laypersons. Each of them has different knowledge claims but mutual interdependences that require cooperation and coordination among actors located at different levels. Thus, one of the main problems lies in the different knowledge systems used by actors that could compromise or create incongruences in cross-level interactions (Young, 2006). In particularly, in important times of significant change as nowadays, the acquisition and use of integrated knowledge system has a crucial role in effectively responding to the challenge of managing complex social-ecological systems. The alignment and cooperation of capabilities to create, verify, absorb, share and, apply new knowledge can be one of the crucial issue to improve the resilience of complex system to natural hazards (Roux, Rogers, Biggs, Ashton, & Sergeant, 2006).

2.2 Data, information, knowledge

In order to examine how knowledge management can be applied in emergencies situations it is firstly crucial to explain what knowledge means.

Generally, a distinction is made between three/four main components: data, information, knowledge, and sometime wisdom. The terms data and information are often used interchangeably with the term knowledge. Actually, it is uncorrected. As Koraeus (2008) argued "*A common trait in defining these concepts is to use a system of progressive embedding, where each step adds a layer of interpretation and contextualisation, but where each such addition also increases the level of cognitive complexity "* (ibid, p.33)

Knowledge was originally defined by Polanyi (1966, 2009) as the process of interpreting and understanding, the act of making use of information and data. Knowledge is what makes possible to take the right decision and to implement the right actions in order to move forward.

Thus, data can be considered as raw facts. If data are organized in a given context we obtain information and when information are interpreted we obtain knowledge. The relationship between data, information and knowledge depends on the degree of "organisation" and "interpretation" (Cong & Pandya, 2003). Data and information can be seen in terms of "measurements" and "observations" indispensable for the cognitive process of knowledge. Knowledge could thus be considered as information combined with context, interpretation and reflection. Additionally, it is possible to identify one more category: wisdom that is the utilisation of accumulated knowledge.

Data is a set of values of qualitative or quantitative variables. It refers to the measuring and the collection of numbers or characters, but it does not concern the analysis and the interpretation of them. On the contrary, information refers to organized and interpreted data, but even if information includes human participation in the organization of raw data, the end product is explicit and can be readily transferred to another entity without any loss of meaning (Roux et al., 2006). Finally, knowledge is a mix of experiences, contextual information and it gives to the decision-makers the bases and the capacities for effective action. This means that knowledge is a cognitive process where the user has a crucial role in determining the outcomes.

The plurality of views in a multidisciplinary field entails cultural differences between different domains which render knowledge understanding and sharing complex and overflowing with obstacles.

As Polanyi argued knowledge can be classified into two types: explicit and tacit. The former is knowledge that can be captured in a database ("knowing that"). The latter is much more difficult to formalize and it is linked to "knowing how". This means that explicit knowledge refers to information and it can only partially represent what we know, because it cannot express the knowledge of experience. Thus, tacit knowledge is much less 'concrete' than explicit, it is rooted to individual's action as well as in user background and values. This is the reason why it is difficult to formalize and share with other people (Roux et al., 2006).

The human factor is crucial in knowledge creation as well as in knowledge sharing. Knowledge is influenced by the creator as well as by the last user, because users are the ones that have to interpret the meaning. This is not a marginal issue, also in the field of computer system development users are included in the information system. Langefors in *Essays on Infology* (1996) introduced the infological equation to define process (*i)* where data (*D)* is a set of data that, depending on the pre-knowledge (*S)* a human have experience during hers/his life and the time (t) available, is produced to information (*I)* (knowledge).

$$I = i\,(D,S,t)$$

D= the sets of data
S= the user and hers/his pre-knowledge
t= the time available to the user for interpreting the data D
i= the information conveyed by the data D
I= the information function (knowledge)

(Langefors, 1979, pp. 22)

The equation demonstrates that data sharing are successful only if users of the intended information system are included in the design process. If the users are neglected in the data definition phase there is a risk that data will be misinterpreted and wrong inferences could be drawn.

2.2.1. Building and sharing knowledge

Also in risk management the policy, management, societal, and traditional knowledge domains create different knowledge according to their own view, demand and application. Roux et al. (2006) recognized five different types of "knowledge creators":

- Fundamental or basic researchers: the knowledge is systematized according to disciplinary lines. The main aim is the progress of understanding rather than the response to specific problems.
- Applied researchers: knowledge creation is driven by practical problems. The knowledge product is shaped on the potential users' needs.
- Policy-makers: this knowledge requires inputs from different fields in order to support decisions for solving problems in practice.
- Operational managers: they use both explicit and tacit knowledge for organizational issues. The explicit knowledge comes from policy-makers' products, indeed, tacit knowledge is based on experiential learning and acquisition of good practices.
- Local communities: The knowledge is based on traditions and experiences and it is transferred in social memory.

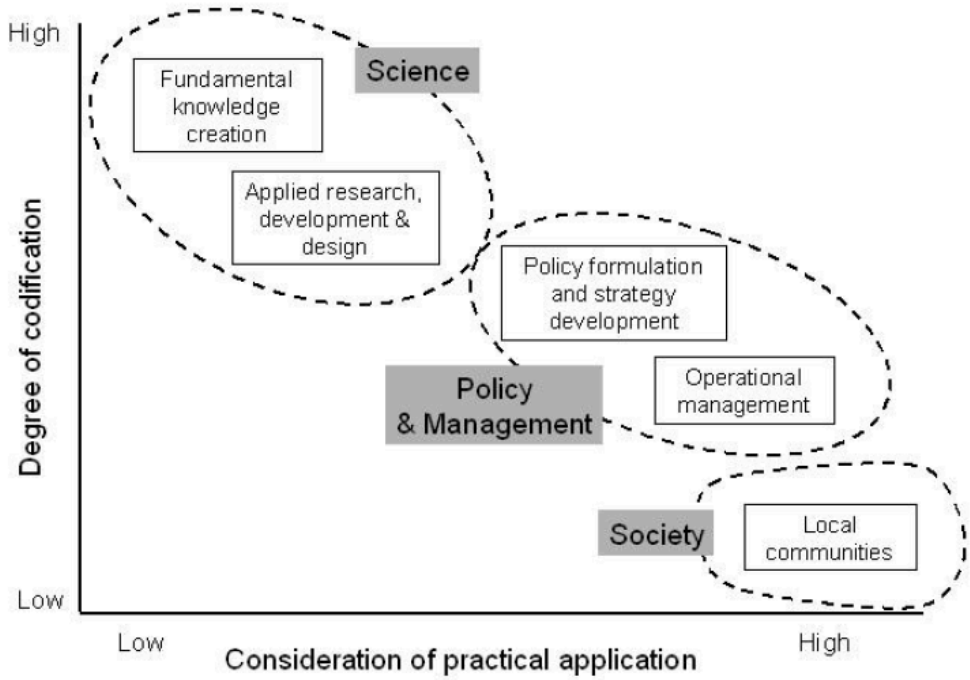

Figure 13 - Different degree of knowledge codification, or explicitness [Roux et al. 2006, p. 8]

As Crosta (1998) argued building and processing the useful knowledge for policies can be "divided" between different workers but nor can it be separated[23]. This means the knowledge in the action is the sum of different knowledge. The professional pluralism poses a predicament for the practitioners who must devise their own way of combing the different knowledge (Schön, 1983).

Figure 13 shows the importance of practical experience and the consequently role of tacit knowledge. Especially in professional practice, problems do not present themselves to practitioner as givens but they must be constructed from the materials of the problematic situations, than they are solved through the selection of the best solutions suited to established aims (Schön, 1983). The perspective used to recognize and solve problems is related to the field of inquiry and it has a strong influence on the potential solution. The adopted worldview and the aims frame could shape very different conclusions from the same information. This is the reason why it is important to find a common conceptual space for the different domains to meet in order to collectively create knowledge (Roux et al., 2006).

The elements that built up the knowledge are influenced by the actors who made themselves available to cooperate during the action. Usually, sectors and levels are linked by rules, procedures, organisational forms and technologies, but that does not necessarily

[23] " *Il lavoro di produzione e trattamento delle conoscenze utili/utilizzabili per la costruzione delle politiche, può essere "diviso" tra più operatori diversi (è ciò che avviene correntemente) ma non è separabile (…)"* (Crosta, 1998, p. 15)

imply a fully interaction. The different actors consult data and information generated from different sources, whatever degree of understanding they have of them. Focusing on disaster operations is not easy to describe the dynamic relationship among actors because different environments generate different types of demands that lead to the formation of different types of response patterns based on different levels of capacity in the system (Comfort et al., 2004).

In Planning, we can assume that the process of the plan put the bases for interaction between actors that anyway not always implies interactivity. Otherwise, the stakeholders' values, norms, their perception of problems and the possibility to building a shared vision through interactive and communicative processes are the core element of the success of an "interactive process" (Crosta, 1998)[24]. The challenge is the interaction system of multiple actors in a framework which is partially structured by shared procedures and norms. For this reason there is the need to harmonize the divergent perspectives that characterized specialists of various sectors in order to realize a joint and coordinated action. If planning is an interactive process it must include a common significance framework and the willingness of learning of the practitioners. This position of "collaborative planning"[25] emphasized the role of mediator in the implementation of the process.

Donal Schön in his studies on learning from practice had developed interesting conceptualizations of the nature of learning systems and the significance of 'learning society' that had become more and more necessary. Schön argued that social systems must learn to become capable of transforming themselves in a changing world.

"The loss of the stable state means that our society and all of its institutions are in continuous processes of transformation. (…) We must learn to understand, guide, influence and manage these transformations. We must make the capacity for undertaking them integral to ourselves and to our institutions. (…) We must, in other words, become adept at learning. We must become able not only to transform our institutions, in response to changing situations and requirements; we must invent and develop institutions which are 'learning systems', that it to say, systems capable of bringing about their own continuing transformation." (Schön, 1971, p. 28–29). The capacity of the institutions to transform themselves, to adapt or evolve it also assumes in social-ecologic resilience and adaptive cycle literature.

Each professional can bring his practice of knowledge into his work. The core competence of practitioners does not consist in the procedural knowledge, but this is just part of the usable knowledge that must be jointed to the tacit and interactive knowledge for starting the planning process *"Actions and interactions will improve the cognitive background since they generally induce further contextual understanding of strategic problems and of the relevance of spatial visions"* (Palermo & Ponzini, 2014, p. 127)

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[24] The notion of interactive knowledge emerged not like a positivist paradigm but more like a strategic paradigm oriented to consensus building (Palermo & Ponzini, 2014).

[25] See "Collaborative Planning in a Stakeholders Society"(Healey, 1997)

Thus, interactive knowledge seems crucial for understanding transformations of complex social-ecological systems. The planning practice needs more than studying statistics and data, it requires interaction between stakeholders in order of building an incrementalist model of practice.

The hardest challenge in this field concerns the sharing of tacit knowledge, but at the same time, the consideration of practical application highlights the potential and hidden role of local communities and the broader topic of public participation.

2.2.2. Knowledge management

Social-ecological systems management relies on multi-faceted knowledge systems in which technique are continuously updated to reflect current understanding and needs (Roux et al., 2006). Usually, important knowledge is created, stored, comprehended differently at different levels and without a cross-levels framework (Cash et al., 2006). The flow of knowledge between the different actors involved is far from optimal. The synergy among all parties is frequently poor, characterized by misunderstandings, conflict and inefficiency. The challenge is the understanding by each part of what they can contribute to the process, and how to integrate these contributions to achieve effective outcomes (Roux et al., 2006).

Misunderstandings characterize all the knowledge systems. Commonly most of the attention focuses on the shift between scientists and managers, but conflicts still persist also inside scientific field as well as among management sectors (Rogers, 1998). Fragmented and unrelated knowledge are of little or no use to bigger purposes rather then related knowledge that could be complementary.

It is false to believe that exchanging information or explicit knowledge between diverse units is easy because several problems could also affect this process. At the same time, it is harder the transfer of tacit knowledge because it requires a much higher intensity of interaction. The essence of managing knowledge is concerned with deciding with whom to share, what is to be shared, how it is to be shared, and ultimately sharing and using it (Cong & Pandya, 2003).

The knowledge sharing should take into account four different concepts: organizational learning, organizational management, learning organization and knowledge management. They all refer to the process of creating, retaining and transferring knowledge but with different focuses and approaches. Easterby-Smith & Lyles (2003) summarized the distinctions among the four topics in relation to their attention on theory, process, content and practice issues (see Figure 14). The organizational learning refers to the study of the learning processes of and within organizations, largely from an academic point of view, meanwhile, learning organization theory generally aims to understand how to create and improve this learning capacity. In the same way, the term organizational knowledge tries to understand and conceptualize the nature of knowledge, whereas, knowledge management approach focuses on creating ways of disseminating and leveraging knowledge in order to improve the action. The cases study, in the next session, will mostly

focus on knowledge for practice (left part of Figure 14) according to the hypothesis that knowledge sharing can be a tool for resilience.

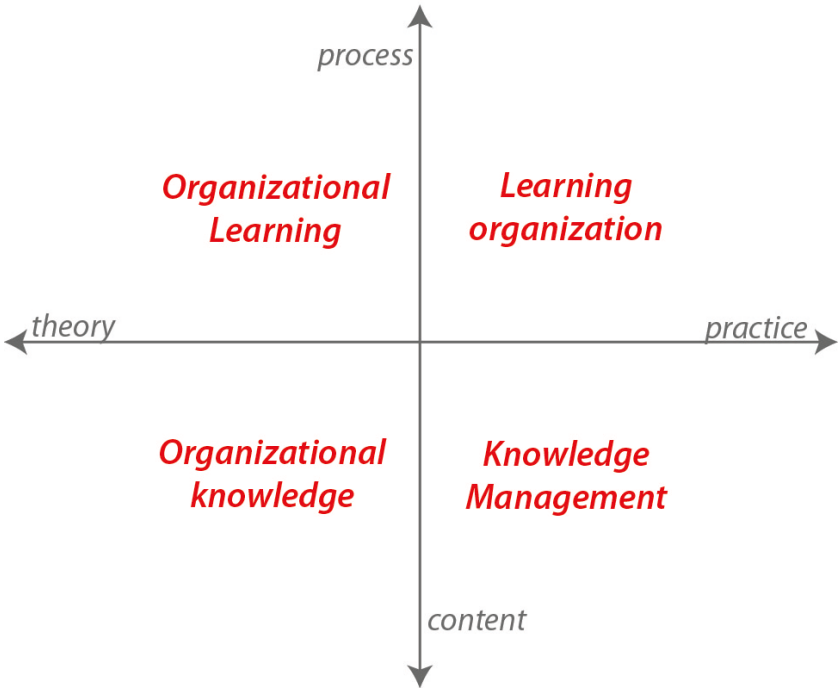


Figure 14 – Knowledge-knowing-learning matrix (Easterby-Smith & Lyles, 2003)

The concept of knowledge management (KM) has been theorized by Ikujiro Nonaka and Hirotaka Takeuchi in 1995 as an enhancement and extension of the existing theories of organisational learning; anyway before it has been practiced for a long time, mostly in an informal manner rather that in a deliberate and systemic manner (Cong & Pandya, 2003; Easterby-Smith & Lyles, 2003). Knowledge management refers to a set of management activities aimed to maximise the process of knowledge creation and integration, including processes of sharing knowledge (Bowditch & Buono, 2005). The main goal of knowledge management should be to optimize resources that already exist in an organization or institution so that its members will be able to seek out, utilize and enhance their activities and processes and increase their performance. Following this premise, KM in institutions can be seen as the ability to use the collective knowledge through a process of knowledge generation, sharing and exploitation.

The knowledge management process involves both explicit and tacit knowledge and improves the capabilities to create an interactive learning environment, where members are encouraged to readily transfer and share what they know, internalize it, and apply it to create new knowledge.

The management of knowledge is based on three key elements: people, processes and technology. People because of the need to stimulate a knowledge sharing culture, processes or methods to locate, create capture and share knowledge and technology to make it more accessible to people (Cong & Pandya, 2003). People are the most important

component, because managing knowledge depends upon individual's willingness to share and use the knowledge of the others. In general, people tend to resist sharing their knowledge with others because of the notion that knowledge is onerous to build and is a property. This is the reason why, the uncertain in number of actors, space and time is the key theoretical variable of knowledge management and sharing (Gibson et al., 2000). Thus, as Cong & Pandya argued (2003) knowledge management is composed by different steps: deciding with whom to share, what is to be shared, how it is to be shared, and ultimately sharing. Its implementation involves systematic approaches mostly with the aim to achieve organisational objectives. During the last decades or so, knowledge management has emerged as one of the most influential new organizational practices and it has had a wide diffusion especially in the private sector (Koraeus, 2008). Its added value is related to the possibility to reduce the time and expense of trial and error and avoid the overlapping in information creation. Nevertheless, while literature on KM has been addressing issues, challenges and opportunities for the private sector, there is a lack of awareness of KM in the public sector (Cong & Pandya, 2003). There are several reasons for this, for instance the significant differences in human resource management policies and practices, the ethical issues and decision processes. However there is a need to develop strategy designed especially for the public sector in order to fill the gaps and enable cross-learning.

The main barrier to knowledge sharing concerns how knowledge is generated, validated and stored. Usually, the parties move beyond the traditional roles of knowledge provider and knowledge consumer in a unidirectional transfer, whereas, sharing knowledge should become a unified learning system among the different actors. Knowledge should be "co-produced" through collaborative learning between experts and users; "*this requires a shift from a view of knowledge as a "thing" that can be transferred, to one of a "process of relating" that involves careful negotiation of meaning among partners"* (Roux et al., 2006, p. 1).

There are many benefits to be reaped from KM. In an organizational setting, benefits can occur at two levels: individual and organizational. At the individual level, KM provides opportunities to enhance skills and experience by working together and sharing other people's knowledge and learn from each other. This aspect is obviously particularly crucial in the sharing of tacit knowledge which is usually difficult to communicate and that requires extensive personal contact and trust to be shared effectively.

At the organizational level, KM provides two major benefits: it improves the organization's performance through increased efficiency, quality and reduction of time, and, at the same time, it enables a better decisions making thanks to the higher data integrity and greater collaboration between different sectors. Alongside, the management of knowledge across government departments can also create new challenges for the retention of knowledge and the preservation of institutional memory.

As, already argued, most of literature on KM has been addressing the private sector, whereas it still underused in the public sector. The main difficulty of KM in public sector

concerns the presence of several stakeholders who are involved in the process, making itmuch more complex to deal with. The structures of public institutions have traditionally been compartmentalized and usually information and knowledge are hardly ever shared across different units and levels. It must be said that sharing knowledge between practitioners with different professional backgrounds is viewed as more complex than within well-established community. Cong & Pandya (2003) assume that the two main necessary changes in this framework are:

1. Raising awareness of benefits of KM among public managers and technicians. In particular there must be a change of mindset from the idea that "knowledge is power" to "sharing knowledge is power".
2. Building an environment of trust. The more trust exists, the more people are willing to share.

The processes and techniques for managing knowledge should follow different stages (Cong & Pandya, 2003): from the identification of the knowledge domain and the gap between the existing and needed knowledge, to the selection of the knowledge that seems appropriate, the consequent classification and storage of the filtered knowledge, and finally the review and the constant update in order to make it available to the users.

2.2.3. Role of technology

As already argued, risk and crisis management depends on a common operational picture to reach a common operational understanding. In this framework technology can represent the way to connect people with information, and people with each other.

However, it is important to underline that the potential role of Information Technology (IT) in supporting knowledge creation, codification, retrieval, transfer, integration and application is not the solution. Several experiences regarding how to capture, merge and analyse information when crisis are in action show the necessity to build up a prior information infrastructure that requests a process able to manage the knowledge among different actors. Including technology has multiple benefits. Information raises the following two basic questions: (a) what kind of information is critical in risk management and (b) how is the core information shared among technicians or institutions?

This is the reason why computer technology does not simply automate existing tasks but often helps to redefine them opening also new possibilities (Kallinikos, 2001). Another benefit of computer-based information system concerns standardization and control. The information produced by computer-based information systems is characterized by uniqueness, that means that it is expressed in a language of description which is intrinsic to such system and that should be common to all the actors who have access to it. But information itself has to be selected, validated and evaluated. To this aim information must be standardized and obey certain rules, otherwise, the systems might not be able to recognize or understand it. Scientists interpret their data based on their background knowledge and experience; thus, different scientists can interpret the same data in different ways. Data interpretation involves constructing a logical scientific argument that

explains data, methods and technics used to measure. In the same way, information can seem in contradiction if scientists do not share a common base line.

The use of IT has been under constant development over the last decade and has become a standard today in the European Urban and Spatial Planning context. Information technologies are often closely included in the majority of knowledge management initiatives.

In this field Geographic Information Systems (GISs) are considered the best tool to support such knowledge because they allow the fusion of many different points of view in a crisis situation. Maps and geographic information both encode spatial relationships in structured formal representations. This formal encoding makes maps and GIS inherently well suited to facilitate collaboration among technicians and experts from different fields but with common aims. GIS integrates many types of disciplines like social factors, roads and infrastructure, land use and cover, environmental base maps. At the same time it concerns activities like georeferencing, map overlay, spatial analysis, visualization and includes both vector and raster data. GISs for crisis management provide a central infrastructure in terms of database, analytical models and visualization tools because much of the data, information and knowledge that underpin critical decisions are geospatial in nature.

GIS already plays a fundamental role in most of the steps of PPRR chain, in particular in prevision and prevention stages trough risk scenarios and risk simulation models, as well as in recovery phase towards recovery plans. Despite the demonstrated value of geospatial information and the rapid increase in the volume and variety of geospatial information sources and models, the usage of GIS is still underrated in real-time response situations. At the same time, the amount of spatial data available and the usage of GIS have both grown, and public and private organizations have become interested in sharing data both internally and with other organizations. This trend has led to the evolution of spatial data structures that rely on web services technology and standardized data formats to allow users to access data distributed from different sources. Thus, GIS has rapidly become the suitable tool for sharing information among authorities and across society (Bank, 2004).

Also the risk management has an interdisciplinary scale, meaning that it touches almost all thematic fields such as environmental, economic and social aspects. Nowadays, this has as consequence a great fragmented planning systems and heterogeneous data management because, by its very nature, it is distributed among many users (Dangermound, 2003). An authority typically develops some, but not all, of its own spatial data content, while, all the other data that the authority needs come from external sources.

Data harmonization and integration basically face two type of heterogeneity: data heterogeneity and semantic heterogeneity. The former refers to differences of data in terms of data type and formats, whereas, the latter refers to the meaning of the data according to the specific context. The transfer of data from one system to another does not guarantee that data have meaning to the new user; it also requires the sharing of meaning

between the two users and furthermore that the two sets of meaning are identical.

Nowadays, geographic information systems are adopted widely but often independently. As a result, it is very difficult for different systems to share data. The two main obstacles to use of GIS are related to (Cai, Sharma, MacEachren, & Brewer, 2006):

- *operation*: the learn ability and usability. The current architecture of GISs requires its users to be specialists;
- *interoperation*: the ability of associating data from diverse source (or systems) and making them work together.[26]

This framework requires for Spatial Data Infrastructure (SDI) in order to overcome the information integration. SDI is a data infrastructure that interconnects GIS nodes across the Internet to share information with one another openly. It works with geographic information from many sources to support a broad range of applications. Despite the early days of GIS, when the focus was on isolated projects, nowadays the focus is on the integration of spatial data and analysis in a collaborative framework.

2.2.4. Social learning

The increase of uncertainties, the rapid dynamics of socioeconomic development and globalization have require a more adaptive and flexible management practices that mix together the capacities of many stakeholders that can speed up the action. The mutual dependence between groups of experts has modified the notion of government as the only decision-making authority; thus non-hierarchical mode of governing prevails in favour of multi-scale and polycentric governance approaches where different stakeholders collaborate in the formulation and implementation of public policy (Pahl-Wostl, Sendzimir, et al., 2007).

Several factors have supported this process such as the awareness that the effectiveness in solving complex issues cannot be tackled without a wider collaboration between government bodies and stakeholders. At the same time, the interdependence between actors is increasing because of the decreasing of governments' budget that demands new approaches to implement effective management strategies.

With regard to resilience, several authors have embraced the importance of the human dimension and the necessity of a wider cooperation among a wide range of stakeholders and institutions in order to evolve toward adaptive co-management (F. Berkes & Folke, 1998). They emphasize the role of networks, leadership, diversity, collective memory and trust. But as Pahl-Wostl, Sendzimir, et al., (2007) explained the difficult question is how these characteristics are developed and sustained.

The term social learning is referred to all kind of processes of learning. Originally, it referred to the learning of individuals and did not consider group processes because the point of departure for learning is the living experience and its cognitive processes. The

[26] The diffusion of internet and its applications are driving much of the interest in interoperability, because they make transfer of data and software possible.

social learning theory emphasizes both issues of knowing and issues of being part of and becoming. For this reason it also spread to group processes such as participation, in order develop shared meanings and values that provide a basis for joint action. Learning concepts applied to whole social entities can be found mainly in the work on organizational learning[27]. Social learning is based on the development of shared meanings and practices and the relation between the individual and the organization and between different entities. Social learning process can be described as a cross scale process.

The framework is provided by multiparty collaboration embedded in a specific context and leading to specific outcomes. It should be based on feedback loop between outcomes and context. In the social-ecological systems the context of social learning includes the governance structure (all the actors, institutions and stakeholders) and the natural environment. The governance structure has a strong influence on the nature of multiparty cooperation and social learning processes because it influences the access to information that can impede social learning. The multiparty interactions regard two different aspects: the processing of factual information about a problem and the problem solving (Pahl-Wostl, Craps, et al., 2007). The issue of management is one of the core aspects of participatory processes because it makes explicit and shared the problem definition, the direction setting, the implementation, the type of ground rules and negotiation strategies chosen and the role of leadership in the process. Likewise, the development of shared meaning for a joint action is facilitated by relational practices (Pahl-Wostl, Craps, et al., 2007). Relational practices may take different forms, such as joint field visit or common training sessions. Benefits of social learning refer both to the measures implemented to deal with problems and to the capacity of the stakeholder group to face problems as well as to enhance the relationships involved. On the decisions side, the quality of the process influences the outcome of decision. In this framework it is interesting to make use of the concept of *communities of practice* developed by Wenger (1998) to analyze the links between knowledge, learning and communities within organizations. Communities of practice are formed by people as a concern for something they do and learn how to do it better as they interact regularly in the process[28]. Wegner emphasizes learning as participative process: learning can be the reason the community comes together or the outcome of members' interactions. Thus, it can be also an unintentionally outcome of the multiparty interaction. Not all the communities are communities of practice. Two main elements define a community of practice: it has an identity defined by a shared domain of interest and its members are practitioners (Wenger, 2000). The members engage in joint

[27] Social learning theory in organizational learning literature has been coined under several names such as "situated learning" (Brown & Duguid, 1991), as "practice based learning" (Argyris & Schön, 1978; Gherardi, 2000), and "learning as cultural process"(Cook & Yanow, 1993; Yanow, 2000).

[28] Communities of practice exist in any organization both private and public. The members of these communities are not bound by organizational affiliations; they can span institutional structures and hierarchies. Communities of practice are crucial to those institutions and organizations that recognize knowledge as a key asset. They fulfil a number of functions with respect to the creation, accumulation and diffusion of knowledge. They are node for the exchange and interpretation of information because they allow the moving of information across organizational boundaries.

activities and discussions and share information but do not necessarily work together on a daily basis. At the same time, fundamental resources are prior experiences and ways of addressing recurring problems.

As already argued, communities of practice can be created intentionally with the goal of gaining knowledge or unintentionally but, in both cases, they take time and sustained interaction. It is through the process of sharing information and experiences with the group that the members learn from each other. The communities of practice can be understood as forms used by actors' networks to manage and generate knowledge. This is of particular interest in those fields in which there are different sources of knowledge and a continuous process of learning. As Pahl-Wostl, Craps et al. argue "*this leads as well to a different interpretation of the role of information and the ability of an actor network to use new information in social learning processes (…)Such understanding of knowledge has implications for the role of information and communication (IC) tools, which range from simple graphical devices to GIS maps as integrated simulation models (…)" (ibid, 2007, p.7).* It may also facilitate the integration of both tacit and explicit knowledge, because it preserves the tacit aspects of knowledge that formal systems cannot capture.

Communities of practice structure an organization's learning potential in two ways: through the knowledge they develop and through interactions at their boundaries.

Despite the collaborative nature of social learning processes, strong leadership and facilitation play a key role. It does not means imposing a view but because of the complexity of the issues of the problem domain, asymmetries among the actors in power, resources and expertise members need some form of direction setting to facilitate solving uncertainties and to take away ambiguities. Hence, the community needs a collaborative leadership able to create the conditions for the convergence of the diversity of actors' perspectives to common objectives. In particular, it is important to determinate how actors give sense and meaning to information in order to frame the issues in the problem. Differences in the framing derive from diversity in scientific disciplines and backgrounds. This means that social learning processes are strongly influenced by the governance structure in with actors are embedded, thus rigid hierarchical and bureaucratic structures are barriers to social learning.

Usually communities of practice arise spontaneously, but that does not mean that nothing can be done to influence their development. To develop the capacity to create and retain knowledge, institutions must understand that they need to build processes by which these learning communities can evolve and interact. It is necessary to build organizational and technological infrastructures that recognize, support and leverage the learning communities.

2.2.5. The public participation

As already argued the success of flow of knowledge depends on the interaction among multi-actors networks. In the last decades diverse shifts has been observed towards new roles and different forms of both horizontal and vertical collaboration among actors because of the growing complexity of the systems and the increasing role of non-structural measures in tackling risks. As a result, the management of natural hazards requires a much larger involvement of the public, with a changing distribution of responsibilities among the interested parties, including not only the multiplicity of public actors but also individual citizens and those from the private sector (Kuhlicke & Steinführer, 2013).

In the past, it was believed that risk management should have had a paramilitary prospective (Scanlon, 1982). The central element was the citizen, who has to be protected, safeguarded or assisted from a set of possible events,. In the same way, all the activities in PPRR chain have been conducted for, not with the community (Laughy, 1991). Nowadays because of the context of increased exposure to risk and a heightened sense of uncertainty, "resilience thinking" has emerged as a key role and it spreads also to community preparedness, forecasting and warning (Scott, 2013). The concept of "evolutionary prospective" of resilience assumed by Davoudi et al., (2012) highlights how much social systems (through individual or collective agency) can adapt or search for alternative development trajectories.

"*Citizens, advocacy groups, private organizations, non-profits, and public organizations from various backgrounds are part of the system, which adds complexity while providing a larger amount of opportunities for public managers to use in effective management of emergencies"* (Kapucu, 2012, p. s42). This means that people at risk are no longer simply exposed to the risk, but they can be gradually transformed into active individuals. In this way, citizens are not more objects but they become new subjects in risk management. Also the EU Water Framework Directive recognizes the need for equitable allocation and the desire for participation regarding water resources.

Different issues have contributed to this evolution. The first concerns the risk perception that is a crucial issue in risk management. In the last years, there is a growing awareness of increasing number of sources of hazards. For example, in the past the source of floods has a sole focus on rivers and sea, but in the last decades new sources are continually unveiled like climate change and flash flood. Also there is a more sophisticated view of causality by recognizing artificial flood sources and the potential for cascading events to widen the impact beyond those immediately affected (White, 2013). This awareness is increased during the "information age" in which people have instant access to an enormous amount of information and news. This does not have only benefits. The large amount of information most of the time increases the uncertainty in understanding the real risks; furthermore, media can contribute to falsify reality emphasizing drama over scientific facts. In the same way, the information about risks that institutions share with the public is related to the credibility and trust that citizens attribute to those institutions (Baggett, Jeffrey, & Jefferson, 2006). Also the different attention in the PPRR-chain can

influence the perception of risk. For instance, the Italian society believes more in emergency response rather than in prevention because of the great capabilities of the Italian civil protection during the emergency. Differently, Swedish society trusts more the prevention stage in order to avoid the emergency.

Nevertheless, in the last decades there is a new emerging interest from citizen groups advocating disaster planning. It has been emerging initially with the risks associated to nuclear power and has been evolving also in relation to natural hazards and disasters (Quarantelli, 2000). People have started to have a proactive attitude in handling risks searching information and warning of dangers. In this field, communicating advice, education and information are growing activities.

Similarly, people have gained to act collaboratively with the authorities. There is an increasing use of the bottom-up approach in which people share information on different platforms: from an "emotional" participation (persons who upload photos and video during disastrous events), to a "conscious" participation, where the information is shared with a community to solve a problem. In particular, with the spread of web 2.0, users become active participants rather than observers (Pearce, 2003). Web 2.0 has suggested a new reconceptualised World Wide Web (Hagemann, Letz, & Vossen, 2007; O'Reilly, 2005), characterized by a more decentralized mode of production, the role of servers as accumulators of content from distributed sources, and the exchange of content among users(Surowiecki, 2004).

The same development has characterized cartography. Usually, reading a map requires some training but today the widespread of Google Maps and navigators makes the user more familiar with maps and geographical data than earlier. The rising of geographical application has improved people's capability to understand the information and hopefully has reduced the number of "map-blind", people with severe problems in understanding what maps describe. The Google tools let the user know and perceive physical aspects of land in a real image that is easy to understand.[29]

At the same time there is an impressive spread of geographic information creation, sharing, dissemination, and use in the form of user-generated web content. Today, data are or could be acquired easily from citizens or through collaborations between citizens and authorities.

Social implication of GIS 2.0, volunteered geographic information, innovation and technologies and crowd-sourced spatial data continue their rapid expansion (Elwood, 2010). Today, several Apps (applications in smartphones) allow that images and graphics

[29] At the same time we have to consider that the contemporary society that uses freely available geo-web tools is much more focusing on where to go and how to get there, while question of "what is it?" and "which are the components of the land?" are not considered due to the lack of interpretative information provided by the web. A deeper knowledge of the landscape elements requires a through interpretation of the objects in an area and a merging with data from already measured road, catastrophe, vegetation, soil map. So, this field has a great potential of improvement, but today we should be aware of its limits and not be deceived by what is apparently spread(Salvemini, Vico, & Iannucci, 2011).

like maps are transmitted directly to the user. Many experts think that geographical information science has much to offer to the development of collaboration technologies in terms of managing teams' knowledge and coordinate teams' actions (Cai et al., 2005). For example, sharing information, by geographical information system support, can be used in order to assist people in case of danger or accident in choosing an alternative route to their destination.

When the public is at risk of a real or potential threat, treatment options may be limited, direct interventions may take time to be organised and resources may be few. In this context, a wider communication could provide individuals and communities with information needed to survive an emergency.

Similarly, people may act collaboratively with the public. Web and mobile platforms are of increasing importance for data collection. They help greatly in both the collection of accurate geospatial data, and the delivery of helpful location-aware applications easily used by everyone. Nevertheless, the main problems in using data provided by common people are data quality, accuracy and integrity.

New trends show how social networking is supposed to improve interactivity between a local government and the public. In some cases, local government can release information to the population; in other cases, citizens create and share geographical information with other people or authorities following a collaborative approach. The following cases study want to provide an overview on the potential and the different services that local authorities use in risk management.

However, also the process of involvement of people is an interactive learning process which needs to take into account past experiences, feedback loops and interaction with others. Therefore, disaster events can reveal a number of conditions as unsustainable. For instance, the strong shock caused by hurricane Katrina in New Orleans in 2005, required a reformulation of a "new order" in terms of society, economy and policies.

3. CASE STUDIES: RESEARCH METHODOLOGY

Chapter 1 and 2 have provided an overview of the theoretical, analytical and methodological framework upon which the thesis is based. Otherwise, the third part of the research corresponds to cross-comparative analysis of two case studies of Swedish and Italian contexts with different type of risk. According to Yin (2009) and (Gillham, 2000) case study research strategy is useful because it allows to understand complex phenomena and meaningful characteristics of real-life events such as organizational and managerial processes. At the same time, the case studies allow to develop or test the theory development taking place in Chapter 1 and 2.

The methods used to complete this stage of the thesis concern: analysis of documentation, critical review of policy/plans/programmes, law and regulations and interviews of the people involved in the initiatives. The outputs of case studies analysis answer to the research questions and help to identify similarities and differences among the cases.

Despite the different contextual characteristics of each case, evidences obtained from cross-comparative analysis will support to understand the main question of the thesis: *What are the challenges that planning is facing in the increasing uncertainty?*

Furthermore, the outputs will provide reflections on the role of knowledge planning in context of increasing uncertainty. In Chapter 2.2. it emerged how knowledge as decision-making tool is considered crucial to the risk society approach in this research. The case studies part has thus been focused on what happens when policy makers attempt to manage a social-ecological system in practice working mainly on knowledge building and sharing. The analysis will investigate the knowledge management-like techniques in search of traces of knowledge management and learning processes and arrangements. Investigations are made on how they have been used and if they have had any significant impact on the management. To this four main questions are explored through the two cases:

1. *How resilience is governed before, during and after the threats?*
2. *How can institutions of government and societal management effectively engage the externalities of the unknown?*
3. *Which role has knowledge for the practitioners? Which is the linking point between knowledge and action?*
4. *How can be strengthened the role of the citizens in building societal resilience and make use of the social media to provide technical support to communicate risks, identify resilient elements and simulate scenarios?*

The two case studies taken for the analysis are the Swedish ecosystem management in Kristianstads Vattenrike (KV) and the geographic information system of the Civil Protection in Regione Umbria (Italy). Both the case studies recognize that the human and ecological aspects are linked, and processes of ongoing feedback are central to the efforts taken in order to manage these systems.

These cases have been chosen because they appear to be examples of a successful collaboration among different actors in order to build a community resilient to natural hazard. In spite of it the approaches to resilience and knowledge employed in the two case studies are significantly different. In the Kristianstad case the central focus is on the flexible institutions and multilevel governance system. Of particular interest is the organizational structure of co-management, the role of leadership and key roles, how knowledge, meaning and visions are generated and spread, how learning and collaboration are carried out at KV.

In the Regione Umbria experience the central focus is on the role of technology (especially GIS) in knowledge sharing and initiatives management. In this respect it provided useful insights into some of the challenges and opportunities for a more resilient urban system.

Otherwise, the two cases are different in the levels and scales of action. The Swedish case focuses on the interaction between different institutions at different organizational levels, meanwhile, the Italian case analyzes the interaction inside the same authority, Civil Protection, but at different levels and scales.

The case studies combine varied levels of analysis. The method used is an interpretive analysis of the case studies that included literature reviews, qualitative semistructured interviews and documents analysis. The different tools were not used in the same proportions in both the cases. The case of Kristianstad is well know in the literature[30] and several authors have already written about that, while Regione Umbria has not literature reviews except for a INTERREG III B- CADSES handbook and a special edition of a magazine written by the same actors involved in the project of analysis.

Subsequently both the cases were refined through an extensive process of transcription from the interviews. People interviewed are in charge of different levels and sectors and were directly or indirectly involved in the activities. Those surveyed for the Swedish case are:

- Margareta Lannér Hagentoft - Planchef - Kristianstad Kommun (Chief of Planning Department Kristianstad Municipality)
- Anders Pålsson Brandingenjör at Räddningstjänsten - Kristianstad (Rescue Service – Kristianstad Municipality)
- Annelie Göransson GIS-ingenjör – Kristianstad Kommun (GIS Engineer – Kristianstad Municipality)

Indeed, respondents for the Italian case are:

- Mr. Maurizio Tesorino - Responsabile Posizione Organizzativa " Sezione 1 – sala Operativa Unica Regionale e Unità di Crisi" – Regione Umbria (Organizational Position manager, Operative section and Crisis section)

[30] The Kristianstad Vattenrike has been considered a successful case study in the literature related to the adaptive governance/co-management, social learning and social-ecological resilience. It was also selected as a best practice by Resilience Alliance (2010) and UN (2000)

- Mr. Paolo Ciaccasassi – Istruttore tecnico ed esperto in gestione dell'emergenza – Regione Umbria (technical engineer and emergency management expert)
- Mr. Utilio Nasini – Responsabile del Servizio Controllo Costruzioni e Protezione Civile – Provincia di Perugia (Civil engineer for constructions service supervision and civil protection)
- Ms. Barbara Montanucci – Ufficio Protezione Civile – Provincia di Perugia (Civil Protection manager)

Ms. Alessandra Ronconi . ANCI Umbria (Association of Italian Municipalities)

3.1 The Kristianstad experience

In Europe, flooding is becoming the most conmen natural disaster, including flash floods that have big impact in short time. This has many causes such as the increasing of human activities with pressure and change in the environmental and climate conditions. Some countries are suffering more than other from the consequences of climate change and they ask for new strategies not only to be able to overcome emergencies but also to live with risks. Annual precipitation trends in the 20th century showed an increase in Northern Europe by 10-40% (Directorate General For Regional Policy, 2009; IPCC, 2007, pag. 544) with strong impacts on ecosystems and strong direct implications for human well-being. At the same time the rate of sea level rise is projected to increase with significant effects like flooding and salinization of ground water and coastal retreat rates (Directorate General For Regional Policy, 2009). Sweden is on of the European countries that suffering more for precipitation increasing and sea level rise. Some parts of the Country are already suffering changes in climate can no longer be prevented. For this reason the national policy requires to municipalities and county administrative boards (Länsstyrelser) and county councils Landsting) to support adaptation policies in order to reduce their vulnerability to climate and reduce the economic and social costs of catastrophic events. As already argued in paragraph 1.2.3, adaptation does not concern only the engineering resilience concept but it is a process that involves also social learning, institutional change and management as well as cooperation.

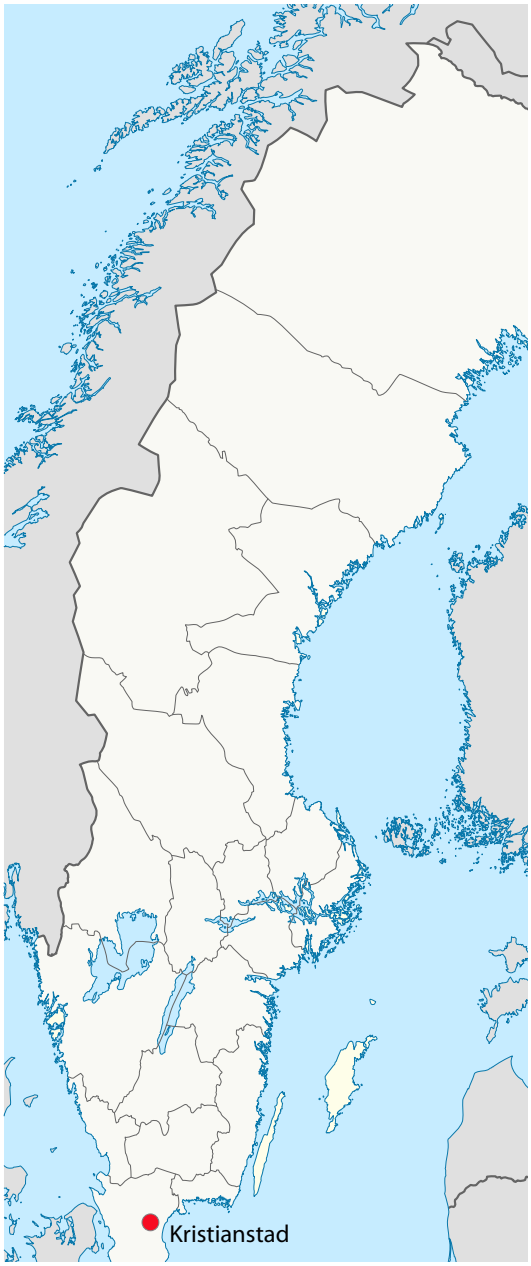


Figure 15 - Kristianstad geographic position (personal elaboration)

In this framework the Kristianstad Wetlands[31] (KV) experience is an example of successful collaboration for ecosystem and landscape management that illuminates many theoretical concerns of adaptive governance, adaptive co-management, and resilience in social-ecological system (Hahn, Olsson, Folke, & Johansson, 2006; Wamsler & Brink, 2014). Kristianstad Wetlands is the name of the lower Helgeå River catchment including the coastal area of Hanö Bay (1,100 square kilometres) and that belongs to the Municipality of Kristianstad, in Skåne County (in the South of Sweden). It stretches 35 km from forests to wetlands with almost 75,000 inhabitants (Hahn et al., 2006).

The city of Kristianstad has the greatest flood risk in Sweden due to its geographical position and characteristics (see Figure 16). Part of the municipality, in fact, is located at Sweden's lowest point (2.41 m under sea level).

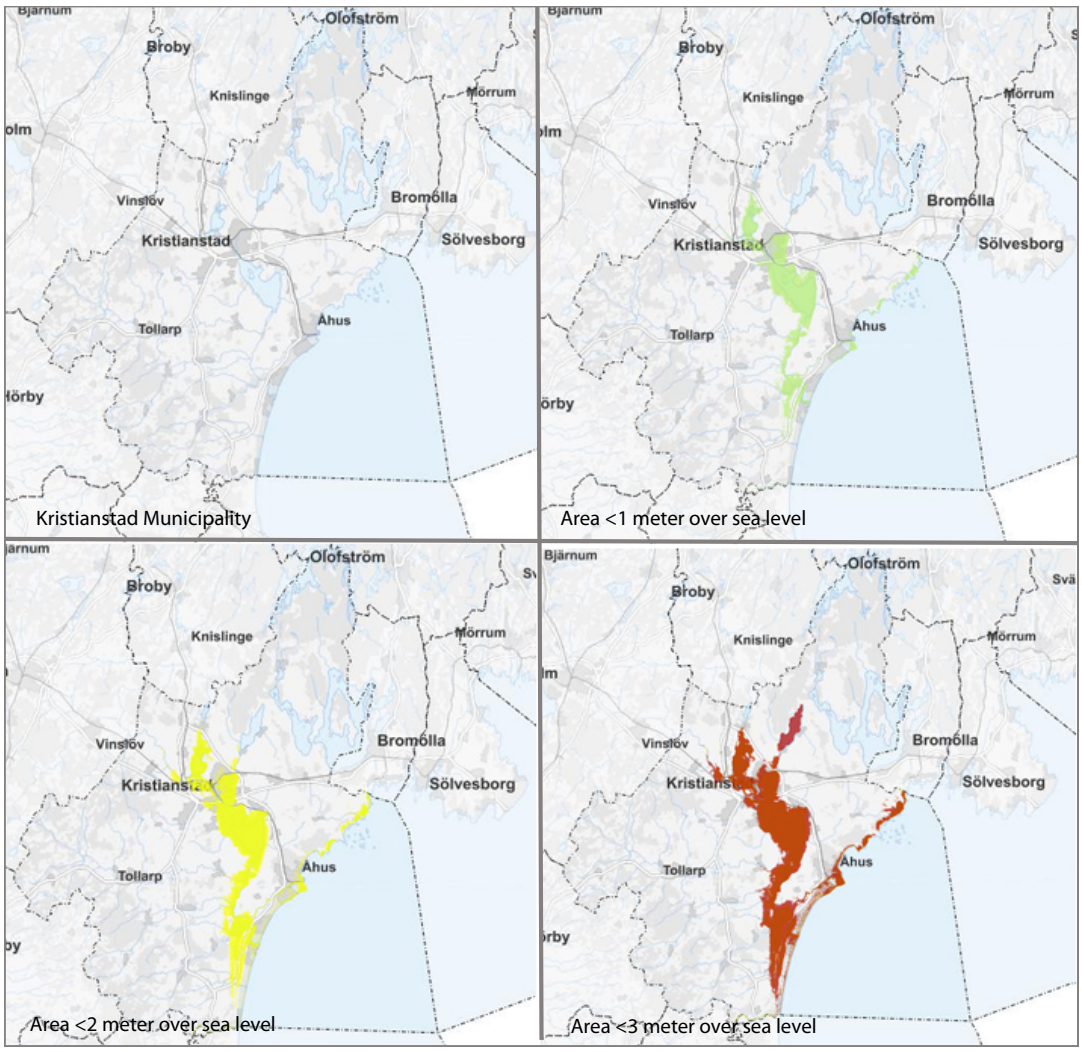


Figure 16 - Flooding area of Kristianstad Municipality (personal elaboration on http://kartor.kristianstad.se/)

[31] Kristianstads Vattenrike (KV) in Swedish. The Swedish name can be roughly translates as " The Kristianstad Water Realm" but *rike* also means riches; the double meaning of the name both defines the catchment area and reflects its rich natural values. (Hahn, Olsson, Folke, & Johansson, 2006)

The natural wetland area is used for pastures and harvesting that are flooded in fall and early spring and can be used only during summer due to the annual average water fluctuation of 1.4 m (Hahn et al., 2006). The geographic location had a defensive aim when the municipality was built in 1614. The ancient city was built on a peninsula to be protected, but in the following centuries the city spread and required embankment to create more agricultural land and new areas, thus, nowadays the city is largely built on the bottom of the former Lake. Essential services such as the hospital, the fire station, the rescue service and schools run the risk to be flooded due to their location.

The flood risk is twofold because it depends both to rising water levels in lakes and rivers and to extreme rainfall. The particular and critical situation of Kristianstad makes it impossible to avoid the risk of flood at all. The municipality has regularly experienced extreme floods (>1.90 m above sea level) in 1980 (2.04m), in 1995 (1.90m), 2002 (2.15m) and 2007 (1.96m)[32]. Thus, in this area the approach to risk mitigation need to evolve because any physical structures cannot give total protection and people and buildings will be exposed from time to time. The new approach requires a combination of coping and adaptation activities. Coping mechanisms means the short-term responses such as closing the traffic in exposed roads or temporary embankments, whereas, adaptive strategies concern both engineering works combined with changes in individuals, households, communities and local institution behaviours. In the case of Kristianstad the adaptive strategies work on different aspects that involve different sectors and different scales:

a) Increasing the awareness of the existing buffer capacity of the wetland and the flooded meadows
b) Resistance: permanent embankments and pumps as well as changes in the land use. This was considered by the municipality of Kristianstad as the core strategy to reduce the flood risk
c) Adaptive urban planning

3.1.1 The Swedish Civil Defence System

Sweden consists of 21 counties: Blekinge, Dalarna, Gävleborg, Gotland, Halland, Jämtland, Jönköping, Kalmar, Kronoberg, Norrbotten, Örebro, Östergötland, Skåne, Södermanland, Stockholm, Uppsala, Värmland, Västerbotten, Västernorrland, Västmanland and Västra Götaland. Sweden has furthermore 290 municipalities, each of them with its own elected assembly.

In the field of civil protection Sweden is working on tools that can facilitate a "whole-of –society" approach for societal security (Lindberg & Sundelius, 2012). The reorganization process is quite new and it is not already properly and entirely realized.

The National Service of Civil Protection was institutionalised by Act n. 225/1992 and it still represents the core of the system. The Legislative Decree 112/98, indeed, has sensibly

[32] Before 2002 most of the people felt safety thanks to the old embankment, but during the flood of 2002 part of the embankment cracked due to geotechnical problems (Storbjörk, 2007).

renewed the distributions of functions between the different levels of government towards a stronger decentralisation and reinforcement of the local powers. The Swedish "Civil Protection Act" regulates operations to prevent and limit injury to people and damage to property and the environment. The system is based on the principle of subsidiarity, where, according to their dimensions, the events shall be managed at the lowest level possible, but if one level is overwhelmed, the next level must be ready to step in and support efforts.

In order to the aim of "whole-of-society" in 2009 there was a key reform that create the Swedish Civil Contingencies Agency (MSB[33]). The MSB organization concerns widened policy filed for crisis and disaster management that includes an integrated approach and different sectors involved in all the different management phases, before, during and after disastrous events.

The main aim of MSB is the coordination among many and different stakeholders. This does not mean that MSB takes over the direct responsibility of actions during emergencies but it should work for building a common capacity for effective action under pressures. MSB is involved with the entire spectrum of threats and risk society (both man-made and natural) and during the all the risk-chain. (Lindberg & Sundelius, 2012)

In the Swedish emergency system each agency has a fixed area of responsibility during normal conditions as well as during the major emergencies that are established through various legislative frameworks. The main document that regulates the agencies' activities is the Emergency Preparedness Ordinance (2006).

In this framework the MSB has oversight over national aggregated risk and vulnerability assessment. All government agencies are obligated to produce and submit a risk and vulnerability analysis to MSB[34] (see Figure 17). In turn, the MSB will conducts a risk and vulnerability analysis starting from the information reported by the other agencies.

[33] MBS = Myndigheten för Samhällsskydd och Beredskap
The New Agency replaced the Swedish Rescue Services Agency (SRSA), the Swedish Emergency Management Agency (SEMA), and the National Board of Psychological Defence (SPF). The Reform is included in the Government Bill 2007/08:92 "Stronger emergency preparedness – for safety's sake"

[34] This require is become compulsory since 2006 by the Emergency Preparedness Ordinance.

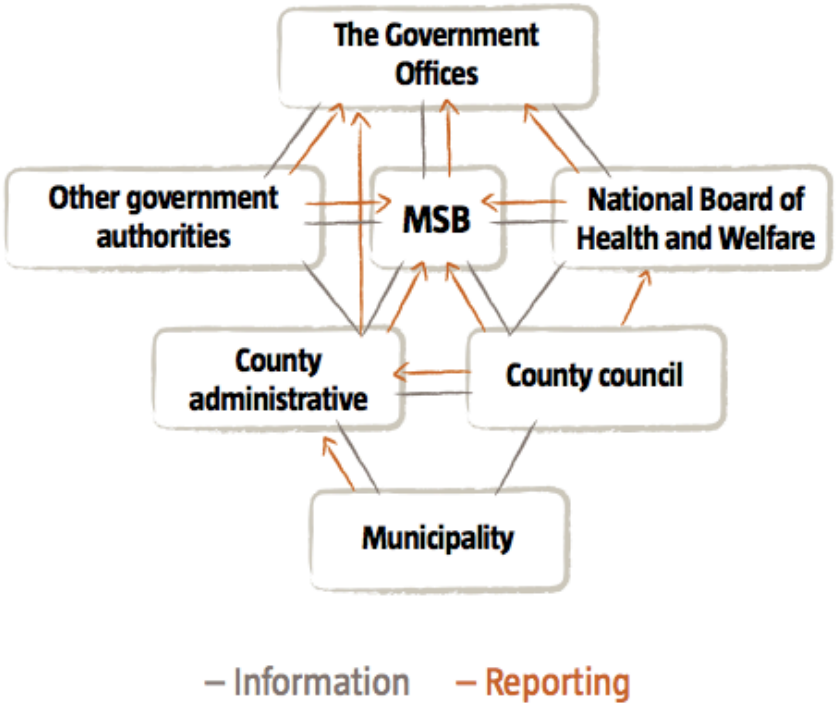


Figure 17 - Information exchange and reporting of risk and vulnerability analyses (Source: Eriksson & Juhl, 2012, pag. 17)

The information flow should occur in two directions where each agency receive and contribute to build knowledge (Eriksson & Juhl, 2012). The idea is to build a comprehensive view that is composed by the mosaic of the analyses of the lower levels. This choice has a twofold aim: on one side the municipal scale has more details and on the other side to simplify the regional analysis of the county administrative board. The latter benefit disappears when the municipalities do not use the same method to define their risk and vulnerability analysis but use different ways.

However, there are three different levels of government for Civil Emergency Planning (CEP): national, regional and local.

The national level

At ministerial level, the Ministry of Defence has overall political responsibility for Swedish CEP. Crisis management at the Government Offices is based on a joint cross-sector approach. The Government Offices are divided up into six areas of collaboration (Eriksson & Juhl, 2012):

- Technical infrastructure
- Transport
- Hazardous substances
- Economic security

- Geographic area responsibilities
- Protection, rescue, and care

Every government office is responsible for planning and handling crises within its own area of responsibility[35]. Authorities and agencies at the national level are also assigned complementary tasks by the government during major emergency situations.

Every government agency is responsible for reducing the vulnerability and enhancing the emergency management in its own area of expertise. They also are responsible of the coordination with the private sector, the municipalities and the county administrative boards. In the same way, the MSB has the task of coordinating the various stakeholders across and between various sector boundaries and areas of responsibility.

The regional level

At the regional level the county administrative boards are responsible for risk and vulnerability analyses and for the coordination of CEP activities such as exercises. It has also the geographic area responsibility that means be the body responsible for focus, prioritisation, and coordination of cross-sector crisis management measures in a specific geographic area. In this case the county administrative board plays as facilitator between different actors and drives the resources according to the priorities of the geographic area.

They also act as a clearing house between public and private partners. They are also responsible for safety and for considering risks related to land use planning. During a crisis, the administrative boards coordinate also the relevant measures with relevant actors. The county administrative boards have overall responsibility for reporting the need for host nation support in the event of a major emergency. Additionally, the county administrative boards also coordinate contact with the mass media during major emergencies, crises, and disasters. The county administrative boards should be also the main container of data on the risks in the region because it has the responsibility to collect the basis of data that comes from the municipalities and the county councils[36].

The local level

According to subsidiarity, Swedish municipalities have a large degree of autonomy and play an important role in civil emergency planning. During "ordinary" time they are responsible through safety in land use planning and accident prevention work in accordance with the Civil Protection Act. In the same way, the "Act on Measures to be

[35] A number of public authorities are represented in each coordination area. For example the Swedish Road Administration, the Swedish Civil Contingencies Agency, the Swedish National Post and Telecom Agency, the Cost Guard.

[36] The MSB regulation for the county councils requires:

- Ability to coordinate, manage and inform the extraordinary events (crisis management capability). The concept of crisis management capacity includes knowledge creation, management structure, robust technical management support and interaction with other players in the crisis management system.
- Ability to carry out operational activities (operational capacity).
- Ability to withstand disruption of critical infrastructure (strength).

taken by Municipalities and County Council in Preparedness for and during Extraordinary Incidents during Peacetime and Periods of Heightened Alert" establishes that during emergency the municipal executive board is the highest civilian authority within the municipality with the support of the County Administrative Board.

The Municipality must identify and evaluate risks, vulnerabilities, and critical dependencies and work towards different actors in coordination as well as must coordinate information for the public under such circumstances. The municipality's risk and vulnerability analysis is an important basis for he analyses at the county and national level, but as already argued, there is not a unique method for this analysis with consequences in term of coherence and comparability.

There are also other authorities that can be involved in particular during the emergencies and that add complexity to the network of actors.

Civil-military cooperation

The aim of civil-military cooperation is to achieve close cooperation as well as a mutual exchange of information in order to handle different kinds of emergencies more efficiently. Civil-military CEP cooperation is carried out at all administrative levels and includes planning, international activities, training and exercises. At the national level the MSB and the Swedish armed forces headquarters coordinate civil-military activities during emergency. An important resource also in case of civil emergencies like forest fires and flood is the Swedish National Home Guard that is a voluntary organisation within the Swedish Defence. The National Home Guard is a part of the Army and as such an important unit of the national defence forces. Personnel are recruited on a voluntary basis and so are the "members" belonging to the voluntary defence organisations that play a significant roll in the units because of their special skills and training.

Volunteers

There are 19 voluntary defence organisations who are involved in both civil and military aspects of CEP. They are all independent and non-profit associations. In co-operation with the authorities, these voluntary defence organisations inform, recruit and train volunteers for emergency preparedness and wartime situations.

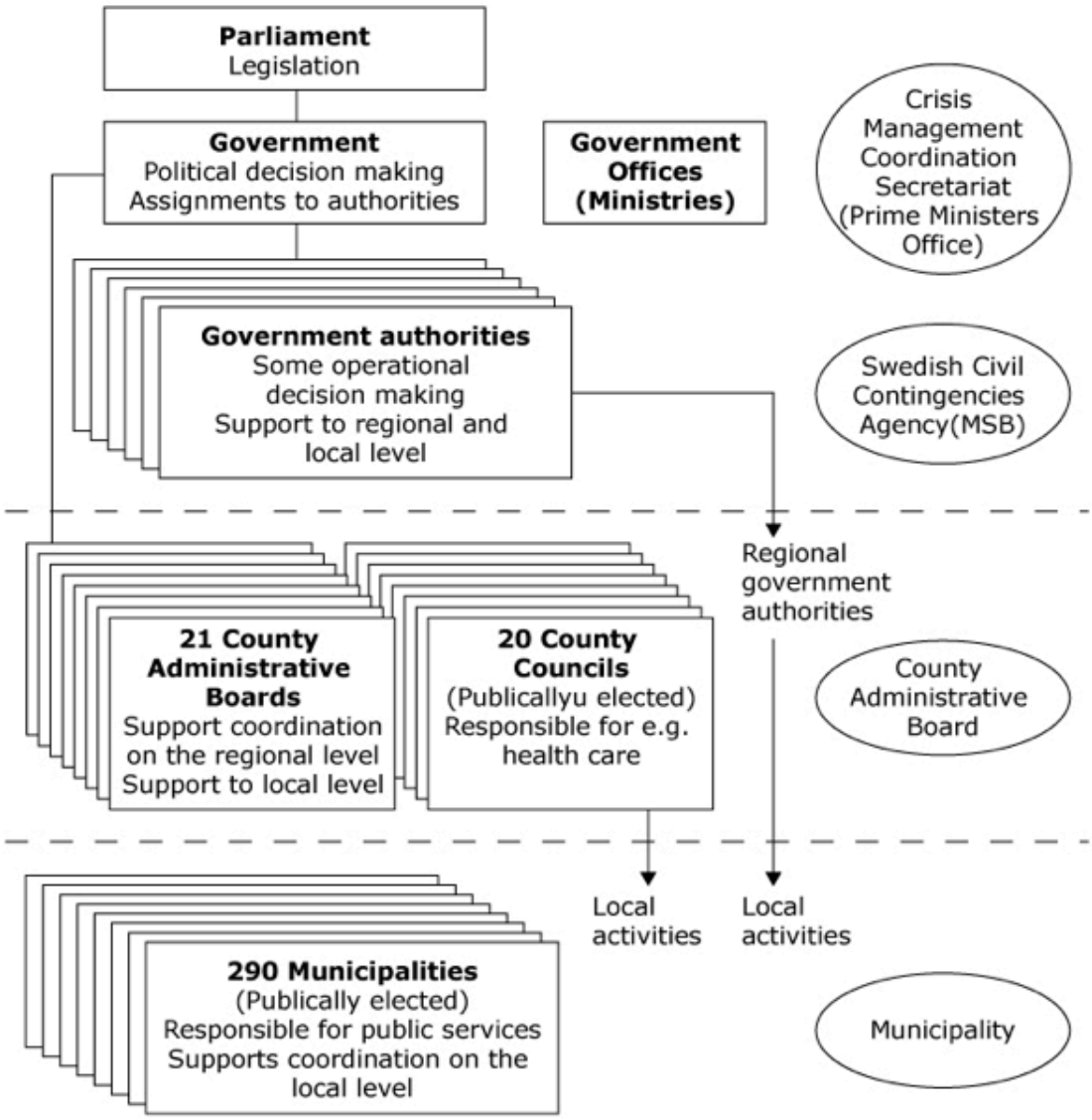


Figure 18 - Organisational chart of Swedish disaster management structure (http://ec.europa.eu/echo/files/civil_protection/vademecum/se/2-se-1.html#over)

3.1.2 Generating and communicating ecological knowledge

The particular geographic morphology of the wetland made it possible, in June 2005, that KV became the first UNESCO Man and the Biosphere (MAB) Reserve in Sweden. The KV, in fact, includes Sweden's largest areas of flooded meadows used for grazing and hay-making. This social-ecological system depends on both proliferation of grazing and hay-making and the annual flooding of Helgeå River. In the past the human activities pressures had threaten the ecological services of this area, but the introduction of an adaptive collaborative process has brought to successful response not only in ecosystem services but also in risk reduction.

In 1989, a small group of inhabitants convinced the municipal executive about the importance of the area for ecosystem management and employ and for this reason the municipality set up the informal administration called Ekomuseum Kristianstads Vattenrike (EKV), without legal authority to make or enforce rules. The purpose of EKV is to preserve the ecological values and cultural heritage connected to water and use the natural resources for economic purposes but has also indirect interests in environmental protection for risk reduction. To its aim EKV promotes a management that treats humans as part of ecosystems and includes social, economic and ecological dimensions.

The KV consists of several projects coordinated by EKV. Since 1989 were defined five sectors of interest (Hahn et al., 2006)[37] :

1. Natural conservation
2. Environmental protection
3. Ecoturism and recreation
4. Education and the Nature School
5. Culture and heritage management

The idea was to bring together all aspects of water management (the lakes, streams, creeks, dams, flooded meadows, and the recipient from the river basin in Hanö Bay of the Baltic sea) to a conceptual holistic approach.

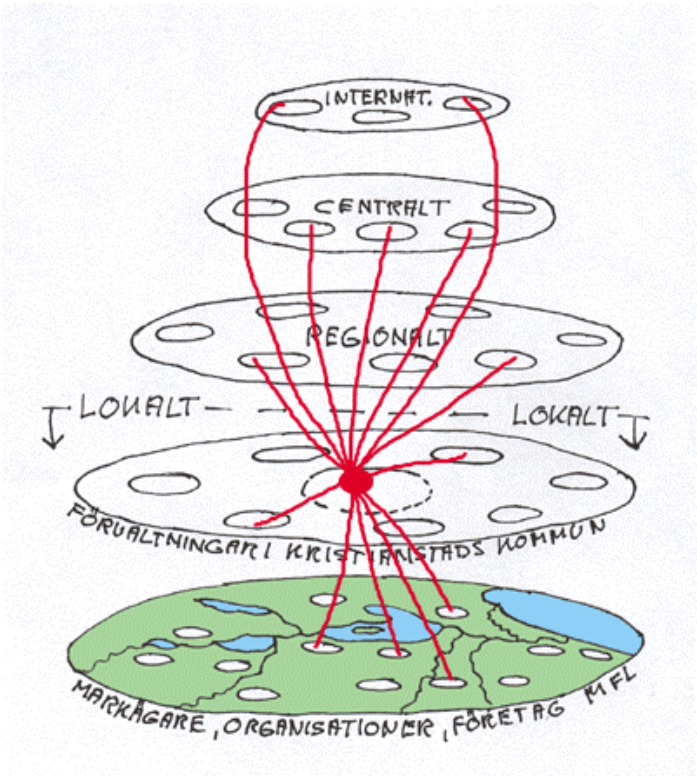
Each section is composed by key individuals that composed the network of stakeholders involved in the management of KV. EKV has the role of facilitator and coordinator in local collaboration process that involves international associations, national, regional and local authorities, researchers, non-profit associations and land owners (Olsson, Schultz, Folke, & Hahn, 2003). EKV is also involved in designing projects as well as in elaborating management plans, agreements or reports of specific area.

The EKV is a small informal, flexible and dynamic organization reporting directly to the municipal executive board. Since the start 1989 there have been several suggestions to subordinate EKV to an ordinary municipal administration, but this solution was avoid because the EKV considers its flexibility as a resource and not as a critical element.

Several authors (Hahn et al., 2006; Olsson & Galaz, 2010; Olsson et al., 2003) argued that the success of EKV is its role and its intermediary capacity to creating networks that

[37] http://www.vattenriket.kristianstad.se/eng/index.php

allows cross-scale interplay. The EKV is the central node of this network that consists of sub-network of different stakeholders groups, that linking scales, and combining different knowledge systems according to the different projects. The EKV played a key role in compiling knowledge and information from various knowledge systems, interpreting and facilitating information flows (see Figure 19). The actors involved in wetlands projects, in fact, have different backgrounds because they included landowners, farmers, technicians and researchers. EKV has thus established essential conditions for feedback loops at different scales.



International Scale
Poland
Denmark

National Scale
Local Investment Program
WWF
EPA
Stockholm University

Regional Scale
County Administrative Board
Farmers Organizations

Municipal Scale
EKV
Municipal Administrations

Sub-Municipal Scale
Farmers/Landowners
Local Business
Local Steward Organizations

Figure 19 - Set of actors of flooded meadow project of Kristianstads Vattenrike (KV). Each project has its unique set of actors, but in all the cases the EKV is the central node of the network. (Source: Olsson et al., 2003)

The EKV create interactive networks of alliances around common interests (Olsson et al., 2003) and at the same time the EKV intermediary function provides flexibility and improves the capacity to trust building (Cash et al., 2006). The trust building processes are fundamental for creating vertical and horizontal linkages, because a lack of trust between people is a barrier to the collaborative management of the systems. Thus, the Kristianstad case shows the role of a key individual for continuous trust building among stakeholders.

The social networks of KV constitute a cross–scale system where the different knowledge are combined in order to create new knowledge, to solve problem and to create feedback loops at different scales (Gunderson & Holling, 2002; Gunderson et al.,

1995). The EKV initiatives had created a trust building dialogue and had mobilized social networks with the actors across scales, and started processes for coordinating people, information flows and generating knowledge, understanding, and management practices. The involvement of community, in particular farmers, adds value because the community-base assessment adds the fine-scale (Hopkins, 2011). The users, who directly influence the ecosystem reveal new knowledge site-specific and at the same time improve their own capacity to manage ecosystem in a sustainable way, improving the resilience of the system.

3.1.3 Resistance and collaborative learning

In the case of Kristianstad, resistance concerns new permanent embankments due to the position of a part of the municipality under the level of sea. The municipality already had a first level of embankments called Hammarslund build during XIX century but it was considered not more adequate after geotechnical investigations that had declared the embankments stability *unknown*.

In order to find new solution, there was chosen the worst case scenarios that of water flows and flood frequency. The worst case scenarios were elaborated by the national authorities (MSB). Storbjörk (2007) in her paper *"Governing Climate Adaptation in the Local Arena: Challenges of Risk Management Planning in Sweden"* (2007) underlined how from the interviews made emerges a communicative gap among officials at different levels with a lack of clarity. In fact according to the local officials the worst scenarios include also the future scenarios of climate change with heightened sea levels and increased of precipitations, whereas, the national officials had declared that worst scenarios were based on knowledge of climate variations over the last 100 years.

However, the deliberation about embankments was supported by a group of technicians (two persons from the local rescue service and two from the municipal technical department) that was part of a larger group called "risk group" formed in 1996 by the municipality executive board (Johannessen & Hahn, 2013). The group's aim was to facilitate and coordinate the building of knowledge from different actors. The worked with the support of Swedish Meteorological and Hydrological Institute (SMHI), the Swedish Civil Contingency Agency (MBS), the Swedish Geotechnical Institute (SGI), the Danish Hydraulic Institute (DHI) and other consultants.

However, different issues contributed to the success of the proposal of new embankments. The first issue was the recommendation of considering a worst case scenario of 10000 years flow rather than 500 years flow. It was the worst scenario time that MSB gave to the application for national funds. While, the second element that supports the construction of new embankments was the extreme flood event occurred in February 2002 because of its critical levels (+2.15 m). Only in 2001, in fact, it was presented the complete risk scenario to the municipality executive board by the "risk group". Thus, the flood of 2002 enlarged the institutional integration because during and after the event strained the capability of the different departments of the municipality as

well as the rescue service to cooperate. At the same time the flood increased the awareness of flood risks for many actors in the municipality. Both inside the institution and among citizens the flood risks became obvious. Instead, before that moment, the municipality's policy used to hide the risks in order to avoid panic in the population.

It must be take into account that the preparedness for 10,000 – years flood changed the impact of the intervention with implication for a larger geographical area. This change had consequence also on the scales, because do not concern only Kristianstad municipality but involve a wider portion of Skåne County.

3.1.4 Adaptive Urban Planning

The exposure to flood risk of the Municipality of Kristianstad pointed out to the administration the need to tackle the potential damages originated from the geographical location and the increasing of rainfalls. Some of the solutions proposed concerned both planning, housing and infrastructure sectors. In particular it was taken into account also the possibility to move parts of the city built in areas most exposed to the risk but, as the spokesman for the Rescue Service Ander Pålsson argued, it was considered too expensive, more than the construction of new embankments and pumps:

> *One of the possibilities that we discussed with the planners and the technicians it was to move part of the city, but it was considered too expensive and finally it was considered impossible to do. However, some parts of the city, which have a fundamental function, were moved like the electricity power station. But the 99% of the city remained where is still today and, for this reason, the final decision was to protect the city with the embankments and the pipe stations.* Anders Pålsson (Rescue Service)

However, even if the main solution was the creation of new embankments and pipe stations the planning sector was involved to find solutions to restrict the damages and hazards and having an efficient response to emergency. The interventions on urban planning system concerns land use and building as well as the systemic resilience during the emergency like escape routes, flood proofing cellars, urban drainage and preservation of territorial elements which can have a remarkable influence on the proper functioning of the entire territorial system.

> *The city plan was changed in 2009* [it was when the new embankments and pump stations were finished] *and it takes into consideration the new embankments and the worst flood scenario. (…)In particular in the detail plan there are special regulations for building companies; for instance it is not allow to people live at the ground floor.*
> Margareta Lannér Hagentoft (Planning Department Kristianstad Municipality)

The regulation for the building concerns stationary elevated houses, floating and/or mobile housing for fluctuating water levels, and the relocation of sensitive activities from flood risk area. Even if these kinds of interventions have positive adaptive effects we can

also assume that in some case they were considered as a solution to allow new building activity in the lower areas. Also the MSB and the embankments group had argued their worries in the past about this issue (Johannessen & Hahn, 2013).

We can find a twofold reason to this. On one side, the new embankments and pumps undermined the usage of a more adaptive urban planning because the infrastructure seemed to guarantee the protection of the city without any other activities. In particular, this conditions citizens' perception of exposure to hazards. On the other side, there was a lack of knowledge in the planning sector able to determine which was the "limit of risk".

> *On planning site inside of the planning department we started to discuss which level of water we should consider as the limit for planning and we also tried to discuss this with the Regional Board.* Margareta Lannér Hagentoft (Planning Department Kristianstad Municipality)

The uncertainty of the exposure to hazard determined also the temporary stopping of city planning in the flood-prone area for a period until the new embankments were built and there were more data about the new risk framework.

3.1.5. A multi- sectoral approach to flood risk

As it was already discussed, the case of Kristianstad is dominated by two type of measures, physical and environmental, that interest different levels and sectors. As Wamsler & Brink (2014) argued there is a clearly dominance of technical approaches that came from the adaptation to climate change experiences in Sweden[38], but the case of Kristianstad is interesting also because of its new way to promote flexibility and the new institutional and organizational arrangements.

A first element of interest concerns the type of measures developed and the sectors involved. In their study on the Swedish municipal adaptation approaches Wamsler & Brink (2014) collected the measures taken by Swedish city authorities in order to investigate if urban actors are able to create disaster-resilient cities. Table 3 shows the different type of measures by the Kristianstad Municipality and the sectors involved. It is clear how different sectors with competing interests are working on adaptation measures but it seems that there is a lack of inter-sectorial communication probably because of the lack of comprehensive resilient mainstreaming across different sectors and levels (Wamsler & Brink, 2014). In truth, there is a comprehensive approach but it concerns only macro-sectors such as natural conservation and environmental protection issues (like the projects of EKV)[39], whereas, it looks weaker and more divided when it comes to the disaster-resilient approach.

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[38] Wamsler & Brink (2014) argued that the phycally oriented measures account for around 60 per cent of the measures commonly taken by swedish city authorities.

[39] The Kristianstads Vattenrike Biosphere Reserve, in fact, is considered one of the best example by the Resilience Alliance (2010) of adaptive freshwater governance.

Measure	Type of Measure	Sector
Physical measures		
Having embankments to lakes to keep historically flooded land drained	Hazard reduction	Environment and natural resource management
Having various pump stations installed (continuously) pump water away	Hazard reduction	Water and sanitation/infrastructure
Temporary stopping city planning in the flood-prone area until the new embankment is built	Hazard avoidance	Planning/ Housing and infrastructure
Adapting land use	Hazard/Vulnerability reduction	Planning/ Housing and infrastructure
Changing regulations/recommendations for lowest level above the sea for new constructions (e.g. + 3 m) (i.e. not allowing construction at all under a certain ground level, or only allowing construction if the lowest floor level is above a certain margin)	Hazard avoidance; Vulnerability reduction	Planning/Housing and infrastructure
Inclusion of adaptation in the urban fabric (e.g. escape routes, flood proofing cellars, retention areas, adapting storm water systems and urban drainage)	Vulnerability reduction; Preparedness for response	Housing and infrastructure
Environmental measures		
Measures to prevent damages from runoff water from upland neighbouring municipalities with help of national grant (because neighbouring municipalities did not want to contribute to the financing)	Hazard reduction; vulnerability reduction	Environment and natural resource management
Having an existing buffer in the form of wetlands and floodable meadows surrounding the city (and giving higher importance to these)	Hazard reduction	Environment and natural resource management
Socio-economic adaptation measures		
Establishing an early warning system for floods	Preparedness for response	Risk management
Emergency traffic planning. E.g. for stopping railway traffic on waterfront embankments at certain water levels or closing the traffic on exposed roads	Preparedness for response	Transportation and tele-communication
Provision of risk information and discussion of related ethical, moral and financial implications	Risk assessment, awareness raising	Planning/Housing and infrastructure
Creation of incentives (economic or legal) for the reduction of soil sealing on private estates	Vulnerability reduction	Planning/Housing and infrastructure

Table 3 – Physical, environmental and socio-economic adaptation measures taken by Kristianstad Municipality (Elaboration of the author from Wamsler & Brink, 2014)

This situation can be related to historical gaps between the environmental and civil protection policy demands (Groven, Aall, van den Berg, Carlsson-Kanyama, & Coenen, 2012) that can be observed at all levels. For example, at the national level the Swedish Meteorological and Hydrological Institute (SMHI) has the role of pushing forward adaptation knowledge in Sweden, whereas, the Swedish Civil Contingencies Agency (MSB) is responsible for coordination and administration of the National Platform for Disaster Risk Reduction. Such division at national level has the current sectorial approach to adaptation planning at municipal level. (Wamsler & Brink, 2014).

However, the Kristianstad case has aspects of interest in the building strategies to reinforce the organizational and institutional assessments in order to analyse the changes caused by the climate change and the increasing of human activities pressure and to find the right interventions to adapt to the new challenges as shown in Table 4.

Strategies for organizational mainstreaming		
Strategy	**Type of Measure**	**Focus/issue**
Establishing an inter-departmental "embankment group" to coordinate internal learning and improve action taking	Awareness raising	Working structures
Mapping of flood risks and analyses of sea-level rise and wave range for risk assessment and planning	Risk assessment	Tools
Establishing new regulations for lowest building level and related requirements	Hazard avoidance, vulnerability reduction, preparedness for response	Regulation and policies
Applying for external funding (from MSB) to be able to afford planning for the "worst case scenario" in building processes	Hazard reduction	Adaptation funding
Putting adaptation higher on the municipality's political agenda – by using past flood events to raise awareness	Recovery	Awareness raising
Using figures (e.g. for maximum flow; lowest building level) provided by national authorities (to not have to take responsibility for, finance and/or defend own figures)	Passive strategy	Regulation and policies

Table 4 - Strategies for organizational mainstreaming
(Elaboration of the author from Wamsler & Brink, 2014)

Firstly, the creation of specialized task groups[40], the revaluation of current staff members and subsequent changes in their responsibilities, and the more interaction with upper levels have increased the diffusion of knowledge on flood risk and have changed the political agenda priority building up a remarkable consensus on the different projects.

> *We discussed what do to from 1995 to 1999. (…) Only in 1999 there was the decision of the Mayor to start the protection of the city and the project started in 2001. (…) At beginning no one took this project seriously but than the next year, in 2002, we had an extreme flood event. This event changed the perception of the risk and was the reason why most of the institutions and people said: "yes, we must do it!"* Anders Pålsson (Rescue Service)

It must be remembered that the changes in the national law and EU directives about the freshwater issue have also contributed to the increasing of flood risk attention. In particular the request of MSB to the Swedish municipalities to perform annual risk and vulnerability assessments as well as the European Strategic Environmental Assessment (SEA) Directive that has legally demand to include a new stronger attention to climate change effects in city planning.

3.1.6 The information flow

In Sweden, responsibility for the practical management of weather-related risks and physical planning rests with municipalities. The Planning and Building Act of 1987 stipulates that municipalities shall account for environmental risks such as floods and landslides in their physical planning (Storbjörk, 2007). Thus, municipalities determinates land use and localizations, whereas, County Administrative Board (regional level) has the responsibility to safeguard and coordinate state interests, supervises local planning, supplies data and work as an instance for appellation of municipal decisions. Despite the central role of municipalities, as already discussed, also the national level has a role. Authorities such as the Swedish Rescue Services Agency, the Swedish Meteorological and Hydrological Institution, the Swedish Geotechnical Institute, the National Board of Housing, Building and Planning (Boverket)[41] should provide input knowledge in risk management and planning and state funding for preventive measures.

Also in the information flow, there is still a lack of integrated risk strategy and multi-sectorial collaboration (in particular at local level) combining different knowledge systems, worldviews and integrating measures. The literature on governing climate change supports the de-centralised control because of the key role of the local authorities though concerning the responsibilities of all the scales (international, national, regional and local levels) (Storbjörk, 2007). Meanwhile, today local stakeholders and agencies

[40] With specialized task groups I want to refer not only to the "embankment group", but also to the different networks created inside of EKV.

[41] In 2008 the Swedish Planning and Building Act established the inclusion of prescriptions and suggestions to natural hazard in construction permits and zoning with consequences on the municipalities.

often cooperate on a voluntary basis, many see the need for a stronger policy directives on coordination at the regional level (Johannessen & Hahn, 2013; Wamsler & Brink, 2014).

According Kristianstad experience, there are three main type of relevant knowledge: (1) ecological knowledge (EKV projects), (2) technology knowledge (embankments group), and (3) knowledge of social processes behind management practices (it presents both in EKV and embankments group).

According to Swedish law the information flow should occur in two directions and each authority should receive and contribute to build knowledge. This comprehensive approach is not supported by a clear method of knowledge building and management and the final mosaic of knowledge seems affected by uncertainty. The information exchange is restricted to the outcomes rather than including the raw data and it does not include the building of a common significance framework. The interaction among actors does not have the characteristics of the interactive process defined by Crosta (1998) and Schön, (1983) (see 2.2.1.).

As also Storbjörk (2007) argued it seems not to be very much reflection of uncertainties related to the knowledge and data input used in risk management. The different actors consult information from different sources whatever degree of understanding they have. However, during my interviews emerged also two other possible answers to this problem. The former seems related to the tools used for elaborating information. The different sectors do not use the same tools and methods (as well as they do not share the raw data) for data elaboration and for this reason there is uncertainty on information building. It must be said that according to Storbjörk this is not only a question of certainty vs uncertainty but also a question of willingness or unwillingness to take responsibility. According to the "*organised irresponsibility"* concept of Beck, (2009), in this way nobody really is responsible for those consequences.

The latter reason concerns the knowledge at local level where there is a large use of tacit knowledge especially during the phase of emergency. The Kristianstad officials demonstrated a deep knowledge of the territory and most of them declared that they lived there since they were born. This could be an advantage in some cases but it can also represent a negative aspect because it gives low incentives for them to collect and store explicit information that can be useful also to other sectors and levels.

> *" We don't have an evaluation of the road system during flood, but we are a small city and most of technicians know which roads to take to evacuate without risk."* Anders Pålsson (Rescue Service)

However, if we look back to the embankments group´s way of building knowledge we fund that it was developed by multiple sources at different scales. In particular, this knowledge was used to reinforce the perception and convince the local decision makers of the risks. In the academic work of Johannessen & Hahn, (2013) emerges how some data and information had not a clear source as well as were used to catch funding. For instance, in 2000 there was the first application for national funds for rebuilding the Hammarslund

embankment. In the report for the application the embankment was calculated to withstand a 500 years flow but after the MSB recommendation that the "worst-case scenario" should be 1000 years flow, the group changed the amount of years, worried to not receive any funding (Johannessen & Hahn, 2013).

The combination of different sources and knowledge illustrates that cross-scale and cross-level interactions are pervasive but at the same time extremely susceptible to misunderstanding and confusion (Cash et al., 2006).

> *If we want to have a sustainable city it is fundamental to cooperate. (…) I think we have a valid cooperation but the compound of the knowledge is made with different models.* Margareta Lannér Hagentoft (Planning Department Kristianstad Municipality)

However, even if there are uncertainties related to the knowledge in the case of Kristianstad it is important to underline the capacity of the governance system of being flexible to promote new institutional and organizational arrangements. Most of the cooperation are voluntary and have started with bottom-up (EKV experience) as well as top-down processes.

> *The cooperation was voluntary but the Regional Board in the late of 1998 tried to make a focus on this issue with a lot of exercises for cities in this area on "how you do when you have flooding problem* Anders Pålsson (Rescue Service)

In both cases the actors involved have a proactive behaviour promoting a collective action and networking. There is the awareness of how knowledge often can be perceived differently at different levels (what is salient, credible and useful), but there is always accountability to the both side of the boundary.

> *Every actor were quite supportive, at the beginning we did not agree at all, we managed the discussion. We managed in some way.* Anders Pålsson (Rescue Service)

The networks play a crucial role in the dynamic relationship between actors and in particular widening of the number of actors seems to increase the possibility of success. A key function is the leadership of the projects. If we look at the Ecomuseum Kristianstads Vattenrike we found that EKV can be considered as a bridging organization that plays a key role as facilitator and coordinator that reinforce the co-management capacities. We can assume the same key role for what concerns the "embankments group". As reported by Johannessen & Hahn (2013), the group had a good interpersonal communication style that can be considered as central to the success of internal learning on the insufficient level of preparation for extreme floods. They played a role in the process by building trust, compiling and communicating knowledge, developing goals and vision for management and mobilizing support.

3.1.7 Building awareness of living with risk

In general, in Sweden the bottom-up knowledge transfer and participative methods generally are non-existent for adaptation issues and for this reason the case of Kristianstad represents an exception (Wamsler & Brink, 2014). In particular, the EKV is a bottom-up municipal-level boundary organization that started as part of County Museum to become a part of the municipal organization. It was born by different organizations and citizens that observed the gradual decline of natural environment. Thus, the interest of citizens started in the ecological field it had consequences also in risk management. During the flood of 2002 all the municipality executive board was informed and at the same time the emergency of that days showed the risk also to the population. The catastrophic event and the following dialogue that started with ordinary people increased the knowledge about the risks. As reported by Johannessen & Hahn (2013) the dialogue with the public increase the willingness among taxpayers to support the projects.

> *Till the 2002 the information was caught in our meetings and were not very public differently from today when we are more open to give information. In 2002 the media made a lot of efforts to give information to citizens about the event.* Anders Pålsson (Rescue Service)

At the same time, the farmers were involved in projects for improvement of the natural storage capacity of wetlands (see Table 5). This also increased the awareness of people's responsibility to implement risk reduction measures. This is a first step of a more proactive role of citizens. Nowadays, the Kristianstad Municipality activities in this field are restricted to give information and create awareness of the risk of the area, but the actors involved understand the benefits that should come from new self-awareness of people.

> *People can contribute. The plan is that they take care of themselves during emergencies. I think that people must know, when they drive, where is the risk and which roads thy can use. Unfortunately we don't practice that. We cooperate with media, we give information on how big the flood is, how it works. (...) We should involve people during calm periods and not only when the risk level rises. The problem is that most of the time there is attention only during emergency. For example at the moment we are in a dry season and no one care about the water level, even if it should be a process and not only a moment. (…) Firstly, it is useful that everyone know there is a risk, because for instance if we have to evacuate people in the middle of the night, people need to know that this is the risk that we had told about. Then - in that situation we just need to say which roads to use to escape.*
> Anders Pålsson (Rescue Service)

Strategies for inter-organizational mainstreaming		
Strategy	**Type of Measure**	**Focus/issues**
Changing from keeping the municipality's high flood risk unannounced to a more open approach to allow cooperation, including publically declaring to allow open dialogue with citizens	Risk assessment and awareness raising	Risk awareness
Actively involving concerned stakeholders in adaptation planning such as farmer and actor seeking to protect the environment and various recreational interests	All	Inter-sectorial cooperation
Using informal or professional networks for adaptation knowledge transfer, such as newsletters or gatherings for engineers working with water (e.g. for defining standards such as for dimensioning stormwater pipes)	All	Networking/Inter-sectorial cooperation
Partaking EU level in projects (e.g. Living With Flood Risk in a Changing Climate (FLOWS) and Climate Proof Areas (CPA))	All	International cooperation

Table 5 - Strategies for inter-organizational mainstreaming (Elaboration of the author from Wamsler & Brink, 2014)

3.2. The Regione Umbria experience: Azimut System and S.I.S.M.A. Project

The Italian national territory is exposed to severe natural hazards some of which are made worse by human activities. Many municipalities are remote, scarcely populated and possess very limited resources for public services, yet their locations are often highly exposed to natural hazards (Bignami, 2010).

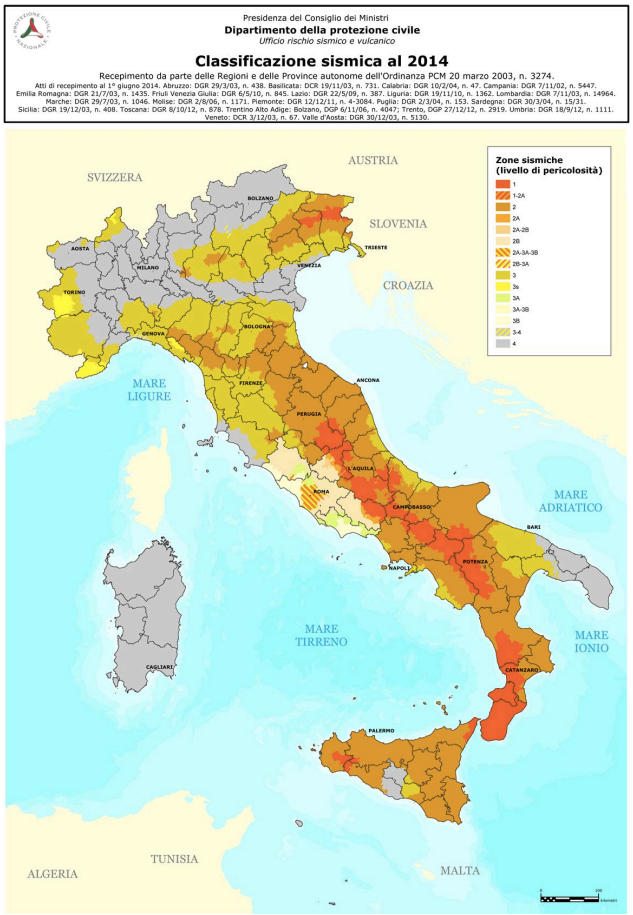

Figure 20 - Italian seismic classification of 2014 (Source: Civil Protection Department)

The main types of natural hazards that affect Italian territory are:

Earthquakes → Numerous seismic faults cover the Italian territory. Up to 40% of the Italian population are estimated to live in highly seismic areas (zone 1 and 2)[42] where 60% of buildings are not constructed according to seismic codes. The most exposed areas are in the Appenine Mountains, the Calabrian Arc, Eastern Sicily and in the Friuli Region on the north east (OECD, 2010). The situation in these areas is made worse by the building stocks quality. Even if the new constructions in seismic areas are compulsorily tied to seismic codes, most of the buildings and public works are not adequately protected also because most of them are located in historical areas. This is the main reason why in Italy the earthquakes still cause serious damages and several deaths and injuries[43].

Volcanic eruptions → Etna, Stromboli and Vesuvius are the most dangerous active volcanoes present on the national territory. In particular Vesuvius is regarded as a particularly dangerous volcano due to its location in the most densely populated volcanic region in the world and because of its violent eruptions.

Floods and landslides → Hydro-geological risks are the most frequently occurring natural

[42] The first laws in this field were born in 1971 and 1974. Nowadays the Italian territory is zoning in 4 zones according to their seismic risks classified by the Peak Ground Acceleration (PGA) and by the frequency of events. The classification is continuously updating because there are still analyses in progress in all the country. Each zone is divided in subzones for a better evaluation at different scales. Nowadays the Italian territory is composed of 175 seismic districts (sea areas are also included), characterized by high or medium risk. These subdivisions allow to identify the different earthquakes and organize the rescue activities.

[43] As already argued in Chapter 1, in 2012, the 85% of geophysical reported damages in the world were registered in the area of Ferrara, Italy, during the two earthquakes hit the area (CRED, 2013).

hazard in Italy. At the same time, the damages caused have resulted in enormous costs for the Italian economic apparatus and in terms of deaths. Landslides in the twentieth century alone caused 5939 deaths, or an average of nearly 60 per year (OECD, 2010). Also in this case, the human activities increased the devastating force of flooding, flash floods and landslides. The Italian territory is one of the densely inhabited areas in Europe and it is seriously afflicted by construction of buildings despite the absence of planning permissions.

Forest fires → The forests cover one third of the country and the hazard of fire increases during the hot season. Unfortunately, fires are frequently set by arsonists hoping to lay claim to the degraded land for new constructions.

Due to the widespread proneness of Italy to risks and disasters, the entire State organization in all its vertical levels is involved in Civil Protection and risk management (from the Ministries to the local authorities and the civil society). The Italian Civil Protection System is considered one of the most advanced in the World, in particular, for the emergency operations (OECD, 2010). Nevertheless the full involvement of authorities and the multi-disciplinarily approach entail a complex system of actors and responsibilities with possible negative consequences on the efficiency.

3.2.1. Actors and responsibilities

In Italy the actual Civil Protection system evolved mostly because driven by emotional reaction consequent to disasters[44]. The actual Civil Protection system evolved gradually over the 20th century. Like in many countries, it developed by the establishment of fire brigade at local level, but it started to involve central government services when events requirements exceeded local capabilities to manage them. Over the years the need for permanent institutions to manage and lead the many civil protection capacities fund had been made clear throughout various ministries, levels of government, scientific institutes, industries and volunteer associations; from forest fighters and national police to volcanic monitoring and canine units (OECD, 2010).

The Civil Protection Service has competences in terms of prevention, forecasting, relief and recovery in case of natural or man-made disaster. Despite this, the entire state organization is involved in civil protection and risk management. In general, government civil protection services at central, regional, provincial and municipal level are now structured to coordinate their operations and resources proportionate to the level of capacity needed, in order to respond to the broad variety of natural hazards and under the principle of subsidiarity.

The Italian National Civil Protection Service (NCPS) consists of the Regions, the Provinces, the Municipalities, the national and local institutions and all other relevant public and private institutions or organizations, which are designated by law as its

[44] Italy is not the only country where the evolution of the emergencies system is a consequence of calamitous events (Bignami, 2010). Also the UE directives related to chemical and industrial risks and to hydrogeological risk were issued in response to accidents.

components and operational structures of the Service. Each of these entities acts within its own competence and area of responsibility. The representatives of the bodies and structures sit on the "Operational Committee" and are meant to ensure implementation of intervention activities in accordance with their specific competences.

The Italian National Civil Protection Service was established in 1992 (L.225/1992)[45]. The Prime Minister, or by delegation the Minister for Coordination of Civil Protection, and the Department of Civil Protection (DCP) have the responsibility to coordinate the emergency operations of the central government, regions, provinces, municipalities, agencies, relevant institutions or organizations, both public and private, and volunteers present on the national territory. Each of these entities acts within its own area of competence and responsibility.

The law 225/1992 defined Civil Protection as a structure based on the principle of subsidiarity[46]. At the lowest level, the mayor has operational responsibility in his municipality; when the municipal resources are insufficient to manage the crisis, the next levels of responsibility are called into play as needed (Region, Province, central government). This law does not intend to centralize powers and competences but it would suggest a propensity towards the intention of harmonising efforts across different levels of responsibility and improving efficiency (Bignami, 2010).

The Prime Minister or its delegate has the power to declare the state of emergency. Thus, Regions, Provinces and Municipalities have responsibility for civil protection within their territorial areas. This means that the first person in charge is the mayor of the municipality that has to organize municipal resources according to a pre-established emergency plan[47]. The support of Provinces and Regions as well as the assistance of central government administrations, co-ordinated by prefects, is brought to intervene when the local capacity is insufficient to manage the scale of the disruptive event.

Usually, the central government provides general orientation and co-ordination, furthermore it participates to emergency activities in case of serious situations. Indeed, Regions and the local institutions are responsible for the promptness and management of ordinary emergencies at local level.

During the ordinary time, the Civil Protection is responsible for forecasting and prevention measures. At national level a Risk Commission was created in order to connect the Civil Protection administrations and the different scientific communities. At this stage

[45] Historically, the law 225/1992 represents the transition from a centralised to a de-centralised system. The transition to a de-centralised system involved all the distribution of competences among levels. It started in 1990 with the reorganization of the territorial division and the distribution of competences among the different levels of governance. Nowadays a new path for local and regional authorities is starting. It concerns the suppression of the Provinces and the birth of Metropolitan Cities.

[46] The Law 225/1992 established the National Civil Protection Service defined the typology of intervention, responsibilities and the types of activities: prevention, prevision, response and reconstruction

[47] More information about the Local Emergency Plans will be discussed further in 3.2.2. and 3.2.3.

the Risk Commission collaborates with the Civil Protection Operation Committee and the National Council for Civil Protection.

However, most of the actors enter the field during the "golden" hours of the emergency. This situation concerns the rescue of survivors and the distribution of basic supplies (food, water, medical care) under pressure of time. The emergency response depends on the magnitude of disaster and the degree of cascade effects, but it also relates on the capacity flow of resources, equipment information and knowledge among the actors involved (Comfort et al., 2004).

The main responsibilities during this step are pending on the fire fighters if the event is considered not critical. Otherwise, Civil Protection or, specific police forces (e.g. Forest Service in case of forest fire events), volunteer services and/or even Military Defence are required in case of wider disasters. The role of coordinator is attributed to a "prefetto", the Italian State's representative in the Province. The coordination during this stage should not be limited to the horizontal interaction among the forces involved, but it should also affect the competent authorities that acted previously in forecasting and prevision and prevention steps, thanks to their responsibilities in resources identification and management in anticipation of such events. This number of institutions involves multiple sectors and scales at different moments in time and the interactions among them determin~~ate~~ the complexity of the institutional sub-system that, at the same time, interacts with the other~~s~~ sub-systems (territory, citizens, infrastructure, etc.) that composed the social-ecological system of the event. In the next section will be shown in detail the roles of the different authorities in the PPRR chain (see Table 6)

Actors/Agencies	Prevision	Prevention	Response	Recovery
National government	X		X	X
Civil Protection Department	X	X	X	X
Prefetto			X	
Scientific research groups	X			
Region	X	X	X	X
Province	X	X		
Municipality	X	X	X	X
Volunteer service	X	X	X	
Fire-fighters Corp		X	X	

Table 6 – The actors involved in PPRR chain in Italy (personal elaboration)

Chain of command

For the civil protection system to function effectively it is important that the appropriate level of authorities (municipal, regional or national) take charge of operations according to the seriousness of the event and within their respective areas of competence.

In an emergency situation it should be first of all made clear who decides and assumes the operational responsibility for the interventions to be carried out. Depending on the geographical scale of an event, the potential for disruption and the ability of the local civil protection actors (to respond to and manage it), the operational and coordination centres of the NCPS are activated.

In such cases, Italy has established a clear chain of command for disaster management.

The Prime Minister is entrusted with the coordination of NCPS and the promotion of civil protection activities through the Department of Civil Protection (DCP), in what is described as a functions-based (instead of competences-based) "architecture". This model for coordinating and mobilizing the wide range of national capacity needed to handle a disaster represents a unique approach compared to the public administrations in most, if not all, of the other countries (OECD, 2010).

The first emergency response, disregarding the nature, scale and effects of the event, must be guaranteed by the local structure or bodies, secondly by provincial and regional administrations. Appropriate support to the mayors of small municipalities is supposed to be guaranteed by the prefects ("prefetto"). The mayor assumes the leading role in coordination of the rescue services and can request assistance from the civil protection structures available and operating in the area.

The role of municipalities

Municipalities have a key role because they are responsible for the establishment and implementation of the Local Emergency Plan (see 3.2.2 and 3.2.3) that includes the identification of the risks that affect the territory, and consequently the best location for the Municipal Operational Centre and the waiting and recovery areas as well as the type of resources. During an emergency the mayor becomes the first responsible for civil protection and volunteers. It assumes the direction and coordination of the rescue services and assistance to the population. The mayor is in charge of the following:

- Assessment of the situation and management of the security or rescue operations, including evacuation of the population;
- Health care and assistance to injured persons;
- Food distribution and identification of temporary accommodation for the homeless;
- Continuous provision of updated information on the situation and the behaviour code to the population;
- Monitoring the municipal road and traffic system with particular focus on rescue operations and evacuation measures;

- Establishing a monitoring point on the municipal territory to maintain situation awareness.

The role of the Prefects

The Prefect represents the central government on the territory, at provincial level, and has the responsibility for coordinating and encouraging integration of the organizations responsible for security and civil protection. For instance, it is responsible of the coordination of National Fire Brigade Corps, the National Forest Corps, the armed Forces, the National Police and National Health Service and supporting the province and the municipalities.

The Provinces

The main task for the Provinces is to elaborate the Provincial Emergency Plan, and in certain cases they are responsible of the coordination of relief operations for municipalities within their territories. There is a rising issue regarding the role of Provinces because they do not have specified powers[48]. The mayors, in fact, are the local civil protection authorities whereas the President of the Province does not have any appointment by law in civil protection matters. At the same time, the prefects are also involved and playing important roles in civil protection, that means there are multiple actors with certain authority making the situation complex and unclear.

The Regions

The Regions are responsible in general for civil protection and in particular for risk assessment, emergency forecasting and prevention programmes for their geographical area.

The Regions have also indirect powers in risk management, in fact, Regions have authority over transportation, education, environment, etc., according to the Italian Constitution. All these sectors are involved into the organization of the civil protection activities and structures in the light of their specific territorial and risks characteristics, thus, a collaborative framework must be built among the different sectors of the regional institution.

In case extraordinary powers are needed due to the actual overwhelming necessities in the disaster affected area and on the basis of requests coming from the local institutions, the Region can submit a request for a Declaration of the State of Emergency that implies the possibility to have exceptional powers towards ensuring a faster return to normality.

[48] In Italy, there is a general dispute going on and concerning the usefulness of the Provinces. This does not regard only civil protection matters but the institutional role of Province. The law 46 /2014 abolished the Provinces as territorial authorities but they will still have administrative powers. Nowadays it is not possible to have an exhaustive framework of what will be the new role of Provinces. Despite this, it is reasonably believed that it will maintain the same powers in the civil protection field. The main change will be in the financial resources limitation because of its new role, with consequences on the planning quality.

Each Region should establish a Regional Operational Chamber in order to face emergency, which must continuously be in contact with the National Coordination Structure (Direzione di Comando e Controllo) and guarantee a 24 hours service.

The National level and the Civil Protection Department

As already argued, the national level has the role of laying down general guidelines and providing coordination. Its appointments have the power to legislate for the identification of methodologies for evaluating risks, and specific plans in the organizational field of the emergency. Only during serious situations the national level has an operative role through the military force.

Instead the Civil Protection Department has responsibilities during the whole PPRR chain. During "peace" time its role is to coordinate, to match and to share the regionals department of Civil Protection.

There are also other authorities involved before and during the emergencies that add complexity to the network of actors, for instance fire brigades, police forces, health facilities, water, gas and power supply institutions or companies, waste disposal companies, telephone companies and local volunteer forces. The main are[49]:

National Fire Brigade Corps

In Italy as in most of the other countries, the Fire Brigade National Corps is an essential component of the operational structure for civil protection, and is in charge of protecting the population and preserving the national cultural heritage from any natural or man-made risk. The Corps collaborates closely with the police in the execution of its operational tasks. The operations command depends on the character of each event. As for the chain of command in the event of emergencies, the responsibility is on the local level and if the scale of the event increases then the provincial level becomes involved and also the prefect. One of the important challenges to achieve is coordination between the different bodies or sectors (health, police, etc.), as they do not operate at the same geographic level.

Italian National Forest Corps

The Italian National Forest Corps plays the role of environmental monitoring and pollution control and certain police duties. FC conducts forest firefighting as well as search

[49] Depending on the type of disaster and the scale even more institutions and organizations can be involved. Some of them are: National Alpine Rescue and Speleology Corps, Ministry of Work, Health and Social Policies, ENAC, ENAV (Italian Company for Air Navigation Services, Electrical Power Service Companies) – GSE (Gestore Servizi Elettrici), Electrical Power Service Companies Terna, ANAS (Azienda Nazionale Autonoma delle Strade Statali -Auto-routes of Italy) and AISCAT (Associazione Italiana Società Concessionarie di Autostrade e Trafori), State Railway – RFI (Italian Rail Network) and Trenitalia, Fixed line Telephone and mobile phone Companies, RAI (Radiotelevisione Italia), Italian Postal system, ENI (Ente Nazionale Idrocarburi – Oil and Gas production)

and rescue operations in the forests and mountains. The responsibilities for these actions, which are part of the National Civil Protection System, lie on the regional level; whereas on the local level, the municipalities and provinces provide the immediate emergency response trough the fire fighters**.** Mapping of the forests is also planned on the regional level but implementation is on the local level which is also committed to assess the risks and have maps indicating the areas where there should be no commercial or residential exploitation of land. There is no single administration with exclusive jurisdiction over the forest and mountain areas. The National Forest Corps intervenes as a police force, but each police force has its own field of action. There are several actors providing search and rescue services in the mountainous areas, which are coordinated locally. The National Fire Brigade Corps intervenes at an early stage to extinguish forest fires, which is most important to enable efficient control of impacts, and coordinate itself with other services.

The Armed Forces

The Italian Joint Operations Headquarters deploys forces from the Army, Navy, Air Force and Carabinieri. It is the main interface office for the Armed Forces with the DCP. Regions, prefects, provinces and mayors can also request assistance directly from the Armed Forces for the management of emergencies. The military forces maintain their own management structure when they are declared at disposal for such operations but are under the operational control of the mayor, or any other relevant body that is responsible in the chain of command and control established for each emergency situation.

It is important to underline that the public weather forecast and meteorological service in Italy are also managed by an armed force, the Air Force. The civil protection system has a strong means to exploit the meteorological data together with seismic and hydro-logical data for real time prediction and forecasting purposes, for early warning and alerting, as well as in the operational information and decision support system.

National Health Service

The National Health Service (NHS)[50] contributes to civil protection through the assessment of needs and priorities for action to be taken and provide, in collaboration with the representatives of the autonomous Regions and Provinces, 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 its use. Furthermore, NHS will propose the potential deployment of expert teams for the evaluation of specific risks, identify potential public health care measures to protect the population and activate support centres, laboratories and other institutions highly specialized in diagnostics and therapy.

[50] Croce Rossa Italiana (CRI)

Technical-scientific support and research

In order to fulfil its task of identifying the types of events, their geographical distribution and the probability of occurrence and risks, DCP has established a structured system of collaboration with the scientific community and research programs through the *"Commissione Grandi Rischi"*, the Major Risk Commission, which is focused on risk assessment. This Commission takes a multi hazards approach and deals with four phases of the emergency management cycle, forecasting, monitoring**,** surveillance and risk prevention of both natural and technological disasters.

Ministries, universities, public research institutes and centres, and public administrations combine forces with the DCP through different forms of cooperation, agreements, understandings and working teams, in order to define both prevention and forecasting measures for the different types of risk. For the fulfilment of the operational responsibilities of the Italian Civil Protection System, technical, scientific and industrial structures are involved with the aim of ensuring the necessary technical-scientific support.

Volunteer organisations

The volunteer organisations represent an important resource in the Italian emergency management. As many as 50% of the personnel involved in an operational response to a disaster may be volunteers. For this reason, in 2001 the President of the Republic issued the Declaration 194/2001 regulating the participation of volunteer organisations in civil protection activities. Also the volunteers are under management and control of mayor during the emergencies. In "peace" time they are involved in some prevention activities and sometime also for mass events.

3.2.2. Territorial knowledge as main resource of Local Emergency Plan

The D.lgs. 112/1998 established the compulsoriness of the Local Emergency Plan (Piano Comunale di Emergenza, PCE). These kinds of plans are the main tool of Civil Protection and should be the basis of knowledge for emergency planning and response. In fact, the PCE is the planning tool that aims to identify the strategies for overcoming emergency situations and reducing the damages. The plan concerns the territorial framework analysis with an in-depth evaluation of the elements of interest (to protect), the components at-risk and the resources and instruments available. At the same time, the plan has several elements of complexity: it should cover all types of risks and include all the different resources; that means the data and information are elaborated at different levels and for numerous end-users with a disparate knowledge of the territory. Usually, the Local Emergency Plans are created by the municipalities and afterwards sent to Provinces and Regions, mostly in hard copy. Some Regions elaborated guidelines to assist municipalities in the draft of emergency plan[51]. Guidelines have a twofold purpose: they

[51] For example Regione Piemonte.

can support the person in charge to realize a complete plan with all the information needed, and can expedite the consultation by other actors, like the Region, during the emergency.

The Plan is aiming to reduce damage risk and crisis with the application of overcoming strategies. Its main objectives are:

- the analysis and elaboration of risk scenarios;
- the creation and management of risk cartography in relation to specific database concerning elements at-risk and useful resources during emergency;
- to give behavioural guidelines for rescuers and population to use during the emergency

In addition, it includes an operative plan that identifies the assembling points, the strategic buildings (e.g. hospital, fire stations, etc.) and the resources available during the emergency. Thus, the plan is the main source of information and knowledge used during an event, but at the same time, it must be a flexible tool according to the event characteristics. It might appear obvious that the data collection during "peace time" has a key-role for forecasting, prevention and rescue activities and this is the reason why data must be easily consulted and always updated. In the same way, all other types of spatial plan should be consistent with the Local Emergency Plan but this is not always taken into consideration. On of the main reason of this problem concerns the technological skills of authorities. On the technical point of view, the report of European Commission on Italian Civil Protection (OECD, 2010) underlines that modern advanced technical equipment are available and used only in certain part of NCPS, for instance systems for sharing the common situation awareness and exercising efficient command and control. However in the prefectures, provinces and municipalities on the other hand only some of these had centres with ~~a~~ modern technological standards whereas others were operating with very traditional means such as fax, telephone or mobile.

3.2.3 From building vulnerability to systemic vulnerability

In order to introduce the Italian case study the first part of this Chapter provides a brief overview on the evolution of the Italian seismic legislation, in particular related to Regione Umbria. Subsequently it will be introduced the case study. Regione Umbria is an interesting case in disaster management because of several reasons. The high seismic risk in this area entails a particular attention from the local and regional authorities to this problem, as well as, the disastrous past events in Central Italy have already demonstrated the high number of actors involved before, during and after an event.

In Italy, during the 1980s the risk management policies were merely focused on building resistance, protection and prevention strategy. The earthquakes measures were claimed to be the sum of the single making at-risk buildings secure ignoring the correlation among the different part of an urban area and the mutual influences that

different elements can have in the urban framework (Olivieri, 2004)[52]. But, earthquake is not only a problem of structural building resistance. In the 1990s, a new concept of a systemic assessment approach emerged and it introduced a first transition from an emergency approach to disasters to wider policies of prevention[53].

Admittedly, the commitment of the legislation is merely the seismic prevention of public and private buildings but it also spread the idea of an efficient systemic urban organization in order to overcome the emergency. An earthquake, in fact, can overstretch the urban systemic assessment with cascade effects in disaster impact. The major disasters (flood, earthquake, landslides, etc.) result into damage to human life, property, communication networks and infrastructures, agriculture, therefore creating resources shortage when they are needed to cope with the emergency.

Complex territorial system is composed of many subsets with specific functions like health centres, civil protection structures, different infrastructures, energy distribution centres, etc. (Sole et al., 2011). These can be either well or badly connected by mutual relations and necessary interactions in order to guarantee a proper and effective functioning of the complex system. In the same way, usually a higher need for emergency operations is near the affected area but if the event afflicts many people and environments in large areas there is a greater demand for different resources in rescue operations.

Thus, there is a growing need of up-to date information for various geographic features during rescue operations in order to manage the systemic assessment during the event.

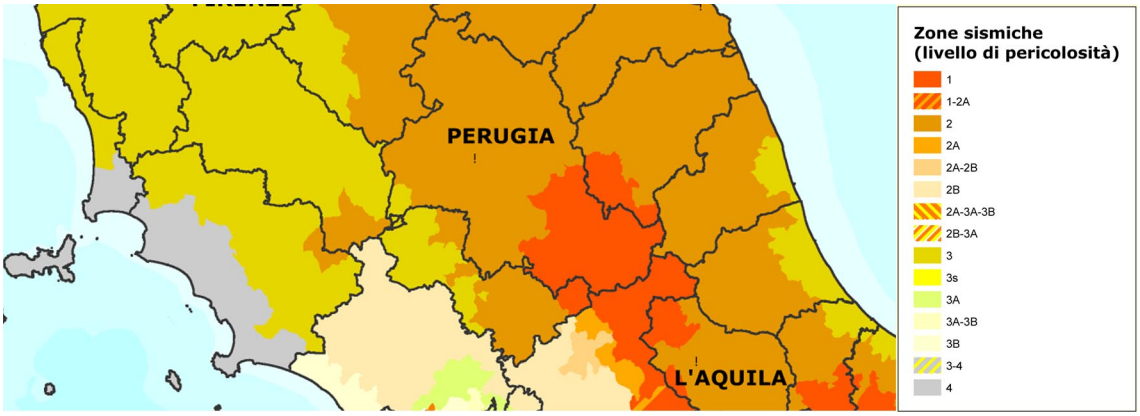

Figure 21 - Regione Umbria zoom of Italian seismic zoning (Source: Civil Protection Department)

[52]The concept of prevention based on building resistance was declared in the national law n.64/1974 "Provvedimenti per le costruzioni con particolari prescrizioni per le zone sismiche". Another limit of this law refers to the concern for the single (new or restored) building only in relation to the national seismic zone classification (that it was different from the nowadays classification that was established in 1981). Thus the zoning was at national scale whereas the prevention activities were at building scale; this difference creates a scale problem that does not allow a reliable evaluation.

[53] In truth, in Italy still prevails the emergency approach. Most activities are still based on planning for disasters or actually on managing interventions following events to reduce losses and damages.

Umbria is a Region of the centre of Italy. It is one of the smallest regions for dimension and population. At the jurisdictional ground is composed by two Provinces (Perugia and Terni) and 92 municipalities. The Region is located in one of the most Italian seismic areas in the centre of the Country and most of its territory is classified of zone 1 and 2 (high and medium hazard level) of the seismic classification hazard (Figure 21). In particular, there are three main seismic districts that cover almost the whole regional territory: Medio-Marchigiana/Abruzzese (district n. 918), Appennino Umbro (district n.919) and Val di Chiana-Ciociaria (district n. 920), (Regione Umbria, 2014). In general, the east part of the region is characterized by high/medium-high seismic phenomena while the west part has a medium- low/low hazard.

On 26th September 1997, at 2.33 a.m., a first foreshock rated 5.7 on the Richter Scale followed by a second one rated 6.1 at 11.42 a.m. hit Regione Umbria. The two foreshocks left enormous damages, especially to the cultural heritage, and 11 dead. The seismic season of 1997, lasting more than six months, forced Regione Umbria to rethink its system to handle earthquakes in particular in reason of its historical heritage and urban centres.

After that period, Regione Umbria had worked and still works on the idea that overcoming a catastrophic event does not imply only the need to protect buildings and guarantee the reconstruction, but also the urban structure integration in a operative system, more complex, wider and with a multi-scale perspective. In this approach the building is integrated in the block, as in the urban structure and the city is a part of a wider scale. This approach aims to identify the systemic vulnerability. This issue has important consequences and shows that structural planning and emergency planning are closely related not only in forecasting but also in prevention activities that have consequences during the response in emergency. The point of contact is to acknowledge the risks that in structural planning are related to the exposure, whereas, in emergency planning are concerned with vulnerability. However, both structural and emergency planning have as key element the knowledge of the territory. For structural planning it allows to identify all the elements needed for the protection of the territory (land-use, buildings regulation, etc.), meanwhile, in emergency planning knowledge is the basis for acting during emergency.

Despite this, these two types of planning do not share a common tool of knowledge and this causes problems of common interpretation and contextualisation. In the Italian system only exceptions to this - defined by law – concern the flood risk: the Plan for Idro-geologic Assessment (Piano Stralcio per l'Assetto Idrogeologico) defines a common knowledge used by both structural and emergency planning. The information included in the plan provides suggestions for locations where the structural planning can take place and the same elements carry out recommendations about forecasting methods in the potential area of disasters and how to manage them. Thus, in this case the instruments of both type of planning are closely related.

On the other hand, for the other types of risks in the Italian regulation there is not a shared and unambiguous knowledge. For instance, the seismic risk is still not

characterized by clarity. In practice, as already discussed, the National classification of risk zones is composed by only four levels which are assigned at national scale. All the evaluations more in detail are, indeed, delegated to the lower levels but without strict guidelines on the methodology.

Since 1998, and in particular after 2006, Regione Umbria has carried on a process of research that intends to tackle the knowledge of the territory in the framework of seismic risk; an unanimous knowledge able to correlate the structural planning to the emergency planning to face the systemic vulnerability.

In the Regione Umbria case, the actors involved in civil protection understood that in order to develop satisfactory plans the key point should be to comprehend how to gain the indispensable knowledge for the plan.

Actually, the law 225/1992 already declared and specified the importance of the data collection and management in order to identify the possible risk scenarios and the areas at risk that are essential to avoid and reduce the effects and damages of disasters (Soddu, Nicolini, & Pellegrini, 2000), as well as , to simplify the supervision of operations. Usually each authority collects and manages the data of its competence and transfers them, upon request, to other authorities. Otherwise, the sharing of raw data is rare between different entities.

3.2.4 Data collection and sharing system

In this conceptual framework, between 1990s and 2000s, Regione Umbria[54] in cooperation with the National Seismic Service, Provincia di Perugia, Provincia di Terni[55] and Provincia di Modena had elaborated a geographical information system specifically dedicated to the rescue service, called AZIMUT.

The Province of Modena at that time was technologically more advanced than the Umbrian Provinces and it was already working on a potential system of data sharing for emergency. After the earthquakes of 1997 also Regione Umbria started to work on this issue, the three Provinces decided to cooperate for elaborating an integrated system for collection and management of all data. This was also possible thanks to the cooperation of the National Seismic System where the Civil Protection of the different Regions used to cooperate. Thus, the system elaborated is the same for the three Provinces (Provincia di Modena, in Emilia-Romagna, and the two Province of Regione Umbria, Provincia di

[54] It must be said that after the earthquake of 1998 several national funds had been given to Regione Umbria in order to overcome the crisis and to reform the process of crisis management in case of new events. Regione Umbria, also thanks to projects and cooperation that were already in progress decided to part the money among all the phases of PPRR chain.

[55] The Provinces were the main backers of the fund. Most of the project – as it will be discussed further – had concerned technological adaptation of the authorities involved. In 1990s some of Municipalities, in particular the smallest, did not have instruments like computers or specific agents able to use software. For the technological adaptation of the Municipalities the 50% of the fund came from the Provinces.

Perugia and Provincia di Terni). Potentially the different databases can communicate among each other.

The idea of AZIMUT was a geographical information system for working out local and provincial emergency plans able to integrate all the essential data and information created by all the different authorities involved in the rescue service. It had a twofold purpose: to create an integrated database and an operative tool, all in one. For this reason it can also be used by different authorities at the same time.

The AZIMUT system is based on the synergy between three different technologies: database, geographical information system (GIS) and on-line communication.

The objective of the project is to build a flexible tool able to respond to different needs caused by calamitous events or unforeseen situations.

As already argued in ,2.2.3, internationally, GIS has already emerged as a powerful tool for analyses and it is used to assess risk, for instance for the identification of vulnerable area for earthquakes, cyclones and other hazards (Cai et al., 2006; Goodchild, Egenhofel, & Fegeas, 1997; Salvemini, Vico, & Iannucci, 2011). The innovation was the idea to use GIS for aid in the preparation and rescue work. Regione Umbria, towards the creation of the PCE trough GIS software, intends to produce a dynamic tool that is easy to update and constantly developing.

Data, in fact, are not conclusive but any territorial or population changes can be uploaded at any time. The data collection during "peace time" allows to include all the useful elements for forecasting, prevention and emergency response in order to have a rationalistic management of emergency. In the same way, the use of information technologies enhances the availability and usability of existing information by adding value through georeferencing and web-publishing collection.

At the same time it promotes the interdisciplinary applications of this information to acquire new knowledge and to improve decision-making through a tool that allows users to integrate it with other types of data (demographic, socio-economic data, etc.) coming from different data sources. One of the main aims of the project was to make the elaboration and sharing of data and information easy among multiple actors and to accelerate the updating process through automation.

It might be said, that at beginning, the project looked like an expedient for organizational knowledge storage, so to combine all the necessary data during crisis time. Thus, the system would firstly respond to the sense of urgency of a crisis where decisions and/or actions are being demanded and there is time pressure. But, later, the system evolved in an applicative tool useful for all the phase of PPRR chain.

The sharing of several data in the same space, in fact, shows a better planning of operations, thanks to the mixture of building and demographic data that are gathered together. These data are used for preparing dynamic hazard maps to identify the population that lives in the area at high-risk, before the event, and to quantify the population that needs to be evacuated during the emergency.

The AZIMUT information system includes all the Municipalities[56], the Region, the Prefecture, the Provinces and the Fire Fighters. It is based on an integrated GIS and Mobile technology for collection and management of all the geometric characteristics (cartographies) and alpha-numeric descriptions (their attributes) of territory, of the civil protection resources (assembling points, reception, etc..) and of the municipality (population, administrative area and other relevant statistic elements of the area – e.g. elders or people with disability, etc.).

The core activity of the system is the data collection that is done in a clear and unanimous way (standardization of data creation). All the users share the same knowledge of raw data and information as well as the data creator and responsible is always active. Most of the data are created at local level, but there are also data showing unlocal values that are released by Provinces (like hospitals, stock areas, etc.). In the same way, some data are used only for purposes at municipal scale, otherwise, they can be used by the Provinces or by both parties. In emergency planning the manageability of the information is steadily growing in importance. For this reason, AZIMUT system confronts this issue through a uniqueness definition of every raw data collection and the usage of a specific symbols database for the cartographic documents.

During the emergency as well as in ordinary time the Region, Provinces and Municipalities cooperate and share all the geographic information related to the emergency plans within a database system. The database has been designed to be not only a container of information but it allows ~~to~~ the municipalities to contribute directly to its implementation in order to have a continuous feedback and increasing quality of information. The centrality of municipal level allows better quality while the sharing of information through Web-GIS technology provides simultaneously to users multiple data sources, like important data such as the population potentially exposed to risk, presence of people with disability or elders, students per schools, etc.

The Web-GIS can be used also during the rescue operations on field. In fact, the rescuers can share information (through PDA[57] with wi-fi) with the Municipal Operations Centre. In this way, the Municipal Operations Centre can receive and give real-time information in terms of injuries, damages, broken roads, as rescuers can require intervention of fire fighters and 118 or analyse alternative route to the assembling and meeting points.

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[56] The Municipalities are divided into *area manager municipalities* and *afferent municipalities.* The area manager municipalities have the responsibilities of the data integration for all their afferent municipalities. In Regione Umbria there are only 11 municipalities with more than 20.000 inhabitants, whereas, most of the municipalities are of small dimensions and they do not have enough persons in charge with the right skills to deal with this kind of technology. In these cases the cooperation with a bigger municipality can help the agents of small municipalities to satisfy all the requests. The Municipal Operations Centre is also located in the management area. As it will be argued later, also the ANCI (Associazione Nazionale Comuni Italiani) disposes of specialists available in order to support the municipalities with the AZIMUT system.

[57] Personal Digital Assistant, palmtop computer.

All the institutions involved have the software able to read and modify its own plan and, at the same time, to share their own database. The system is composed by several parts according to the role:

- Azimut – base module: It is the software of database management. Each municipality is responsible for the creation, updating and improvement of its own database where data are georeferencing and collected according to the Augustus Method[58]. The module has also the MapViewer software (GIS) based on Esri technology for creating projects, views, legends, print. It also includes the NetAtlas Client software for data sharing.
- Azimut – Server module ("hub"): this module is the connection among the base module of the different municipalities. It is used by municipalities that have the role of area manager or, otherwise, by authorities like the Region, Provinces, Prefecture, fire fighters, etc.
- Azicomm: it is a messaging server for communication spread among the different operative centres. It aims to check and manage the information flow before, during and after the event. The Province must supervise this server.
- ArcGis Server: a web service for the data visualization and analysis of the geographic information.

This structure of the system gives the opportunity to have a different data flow were the actors are providers or applicants according to their responsibilities. Nowadays only the upper levels can visualize the whole tiling of geographical data, whereas, the municipalities can visualize only their own data or the data of afferent municipalities. However, also the data flow contributes to the responsibilities determinations because it defines the creator of data and the interactions between the different authorities.

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[58] The Augustus Method is a *modus operandi* established by the law n. 225/1998. The Method gives the management procedure to follow during an emergency. In particular, it allocates the responsibilities to the different levels and authorities and defines the different "Support Works" (Funzioni di Supporto). The Support Works cover several dimensions at local and provincial levels (Bignami, 2010):

1. Structural and planning work (local and provincial levels)
2. Health, social and veterinary assistance (local and provincial levels)
3. Communications and mass-media (provincial level)
4. Volunteers (local and provincial levels)
5. Materials and Vehicles (local and provincial levels)
6. Transportation and mobility (provincial level)
7. Telecommunications (local and provincial levels)
8. Essential Services (local and provincial levels)
9. Census of damages and injuries (local and provincial levels)
10. Operative structures for rescue services (local and provincial levels)
11. Local authorities (provincial level)
12. Dangerous materials (provincial level)
13. Assistance to the population (local and provincial levels)
14. Coordination of operative structures work (local and provincial levels)

As the Figure 22 shows, the Province plays a central role[59] in the system in assisting and coordinating the other institutions. The Municipalities are the main providers and managers of data. On the other hand, the Region, the Prefecture, and Fire Fighter are merely applicants of the information during the events. There are also other authorities that provide data mostly on the Province request.

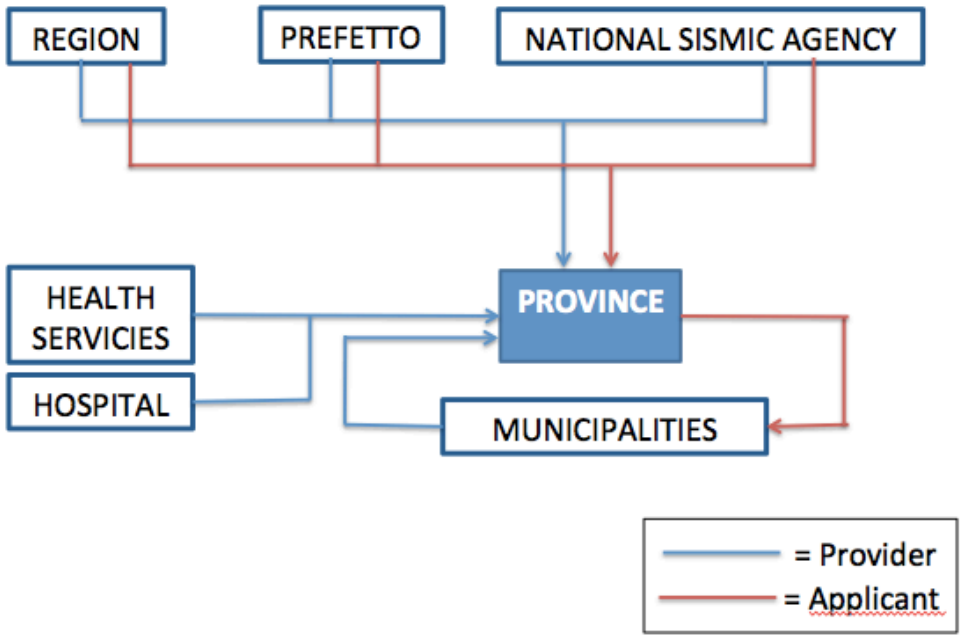

Figure 22 - Data flow between providers and applicants

Finally, in 2012 there was an evolution of Azimut in a new system called SRD (Sistema Raccolta Dati, data collection system)[60]. The main difference in the new system lays on the software structure that allows creation and direct georeference of data trough the new Data Entry (SRD) and that can be consulted by a WebGIS without the need of a GIS desktop software.

The birth of AZIMUT system, and its evolution to the new SRD system, was mostly a top-down process, and for this reason several issues therefore were underestimated. For instance, at the beginning, a lot of municipalities did not have specific offices for civil protection or the municipal technicians did not have proper informatics competences. The provincial technicians declared this problem during the interviews:

[59] The law 35/2012 established a reform of territorial authorities with the abolishment of Provinces and the institution - in some specific cases - of Metropolitan Cities. Nowadays, it is not clear if the Provinces will still have responsibilities in rescue services issue, and the consequences for the AZIMUT system. According to the law, Provinces will maintain part of the administrative issues, but it is too early to have a final picture.

[60] Usually the new system is also called Azimut-SRD

The Municipalities were involved by the Province when the draft project was already defined in agreement with Region, Provinces and Prefects " Barbara Montanucci (Provincia di Perugia)

According to us the decision of involving municipalities only in a second moment was a critical aspect. At that time we overestimated the skills of the municipalities in the civil protection field as well as the informatics competences of municipal technicians. At the time, in the smallest municipalities there weren't even computers or the~~ir~~ technicians did not have enough skills to manage a software like GIS. Utilio Nasini (Provincia di Perugia)

For this reason, it took five years to include all the Municipalities in the project. The little skills of Municipalities was also one of the reason why they were parted in area manager municipalities and afferent municipalities, because, the hypothesis was that the area manger municipalities could technologically support the afferents.

Thus, there was the urgency to help municipalities in creating databases. (…) One of the main hurdles was to find who could be the person in charge for this job in each municipality. This was hard, especially, in the smallest towns, where technicians were few (sometime just one) and they had to cover different functions at the same time. Barbara Montanucci (Provincia di Perugia)

At beginning the help of Province would be only in term of founding and coordination, in reason of the subsidiarity. But later, there was the urgency to buy computers and to elaborate new programmes to support municipalities without which we would have not been able to accomplish Azimut. Utilio Nasini (Provincia di Perugia)

For this reason in 2004-2005 a group of people with ~~a~~ specific skills in civil protection[61] was hired in order to support the Municipalities in the data collection. After that, with the Opcm[62] 3606 and 3624 in 2007[63] this assignment passed to specialists of ANCI Umbria that had the role to support local technicians with their competences in the data collection and in the use of AZIMUT (Progetto ANCI di assistenza ai Comuni, ANCI Project for municipalities' support). Each municipality has a referenced specialist of ANCI who helps the municipal technicians to satisfy all the requests of the Province and Region for civil protection. The role of ANCI specialists has increased the standardization[64] of data and also the type of data collected. For instance:

[61] After the earthquake of 1997 the University of Foligno activated a degree in civil protection in order to support the new requests of specialists in civil protection field.

[62] Opcm= Ordinanza del Presidente del Consiglio dei Ministri (Ordinance of the Prime Minister)

[63] After the Opcm 3606 and 3624 in 2007 regarding the risk of fire, Regione Umbria adjusted its own law and introduced specialists for helping the municipalities in analysing and elaborating fire and hydrogeological scenarios.

[64] In Europe the major recent development on standardization was the INSPIRE Directive of May 2007 that established an infrastructure for spatial information in Europe to support Community environmental policies, and policies or activities which may have an impact on the environment. To

In some municipalities there are technicians with a deep knowledge of their territory and we decided not to lose this kind of information. For example, I remember a municipality whose technician was so willing to georefer all the water pipes useable for fire, as this is very important for fire fighters. However, the first step was the same in all municipalities: to collect and create the essential data for the Azimut system, later in a second place , where possible, we collected and inserted in the database all that data that could also contribute to overcoming the emergency. This double-level approach can be very important in regions like Umbria characterized by small municipalities. The big municipalities, in fact, have more technicians and skills in doing this kind of job, but in smaller municipalities the technicians have often a deeper knowledge of that specific territory, because they live there, they have social relationships in that context, etc. Alessandra Ronconi (ANCI Umbria)

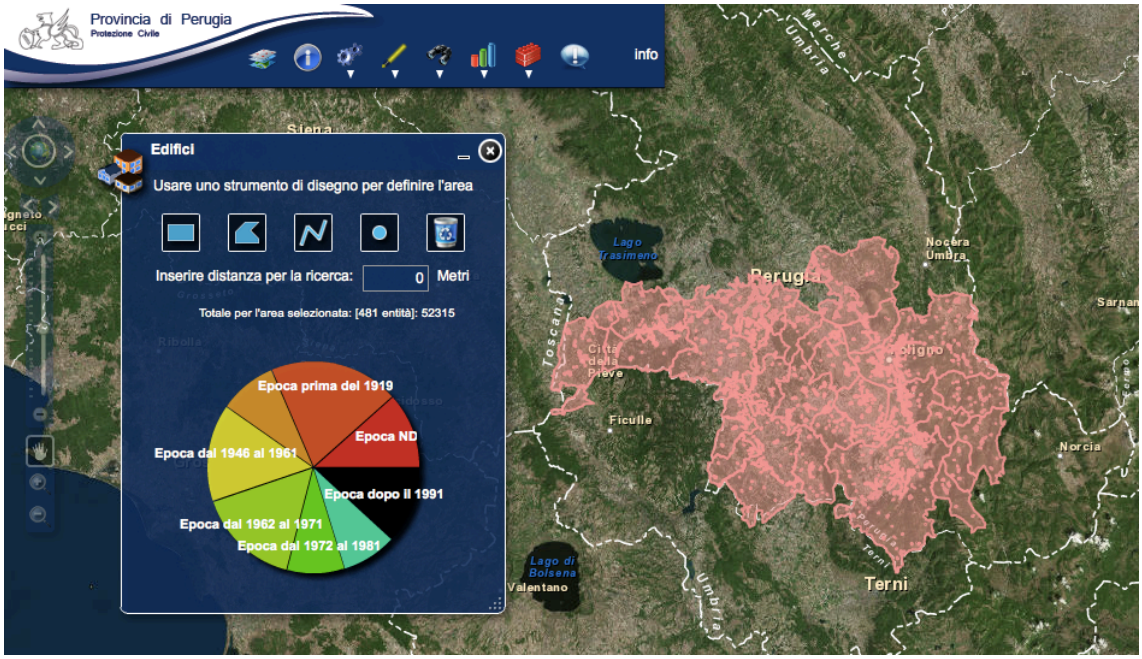

Figure 23 - Azimut screenshot

ensure that the spatial data infrastructures of the Member States are compatible and usable in a Community and transboundary context, the Directive requires that common Implementing Rules (IR) are adopted in a number of specific areas (Metadata, Data Specifications, Network Services, Data and Service Sharing and Monitoring and Reporting). These IRs are adopted as Commission Decisions or Regulations, and are binding in their entirety. The Commission is assisted in the process of adopting such rules by a regulatory committee composed of representatives of the Member States and chaired by a representative of the Commission (European Parliament and Council, 2007).

3.2.5 Building a resilient community

As already discussed, the interest in the case of Regione Umbria concerns the new method chosen for sharing knowledge among different authorities. But, the interest for the Umbrian experience does not involve only the Azimut-SRD project that can be assimilated to knowledge management practices. The choice of widening knowledge in order to increase the resilience of the territory in tacking emergencies, also pursues through the enlargement of actors involved and in particular the citizen.

As already argued in 1.1.3., the risk is caused by the interaction of three different factors: Hazard (H), Vulnerability (V) and Exposure (E):

$$R = f(H,V,E)$$

According to this definition, its prevention and reduction depend on the actions towards to these elements. In the case of earthquake is not possible to work on the Hazard reduction because it is linked to the territorial morphology; instead actions on Vulnerability and Exposure can prevent or reduce the negative effects of a catastrophic event.

As it already debated, in Regione Umbria case the activities on vulnerability and exposure are based on the concept of urban vulnerability concerning actions on: the building stock, the urban structure and the coordination during the event.

In addiction to these activities Regione Umbria has also increased the involvement of citizens towards the awareness of coexisting with risk. For a community has to deal with disaster risks, a shared common knowledge about the preventive measures and the better behaviour to overcome emergencies is indispensable. The institutions pursue the citizens' participation in different ways. The most common actions in Italy in this field concern education and information activities especially in the schools and for public officials and technicians. But, in the case of Regione Umbria, new ways were also experimented especially through two projects:

- S.I.S.M.A. project (System Integrated for Security Management Activities). It was part of the INTERREG-CADES. The project was composed of two parts: the first concerned the architectural and cultural heritage vulnerability, while~~,~~ the second part considered population training and information, to promote the image of the *"citizen as the first rescuer",* to increase awareness in population in front of disasters, for their own security and for active collaboration with the Rescue Management Agency.
- Emergenza Umbria Web-App: it is a web site and an app for mobile that gives the opportunity to citizens of accessing information related to a specific area and alerts of the risks present in the zone of interest. These information can be useful for citizens in ordinary time because they can have a better ~~ac~~knowledge of the risks of the territory where they live, as well as during emergencies.

S.I.S.M.A. project

The S.I.S.M.A. Project is a complex programme part of the INTERREG –CADES. It was composed by six work packages (WP) with two main objectives:

- Definition of an integrated methodology process, that serves to evaluate the degree of vulnerability of the *"historic center system"* and if its components with regard to natural risks, tending to create instruments and prevention actions to reduce risks, through institutional bodies for land management.
- Increase of the awareness in citizens on the degree of vulnerability of their own urban system that allows them to act as "*first rescuers*", especially those who know how to move in an emergency situation, improving their own security.

Even if the first objective also has several elements of interest for this thesis[65], in this section the attention is paid to the second part of S.I.S.M.A. Project and its aim to enhance a culture of risk prevention.

The concept of "*citizen as first rescuer*" aims to improve the self-protection measures of a community. The main aim is to increase the sense of responsibility of population and proactive behaviours, which vary in range from awaiting rescue to a leading role in action. This innovation is based on the collaboration of *"capozona"*, selected citizens proposed as referents. They have to ensure a safe and proper evacuation of the population in their assigned area. The capozona also has the responsibility to share information (through PDA with wi-fi and connection to the Azimut geodatabase) with the Municipal Operations Centre. In this way, the Municipal operations Centre can receive and give real-time information in terms of injuries, damages, broken roads, as capozona can require intervention of fire fighters and 118 service.

The public involvement has been supported by three operations: first, GIS analysis for alternative route to the assembling and meeting points; second, the use of clear symbols (in mapping and in the streets of the town), and third the use of GIS technology to support "capozona" and the Municipal operations Centre. The GIS technology allowed to test the resilience of the system and to verify the use of integrated GIS and Mobile technologies to support the participation of public during emergency management.

It was tested in 2010 in the town of Montone[66], an area at high seismic risk. The purpose was preparing an "organized" evacuation in the historic centre of the town characterized by a narrow group of houses surrounded by ancient walls. The idea was to develop an active behaviour of the population, from the beginning of the emergency until the rescuers arrival.

> *Each Municipality has a referent in case of quake, it is the right-hand man of the authorities in the territory. For example: in a specific municipality we know there is a*

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[65] Some elements of the WP 3 "Percorsi progettuali per la pianificazione urbanistica e programmazione integrate" concerning the connection between town planning projects and emergency planning will be discussed further in this chapter.

[66] The choice of this municipality is related to the first objective of S.I.S.M.A. project that covers with the vulnerability of historical center system. At the same time this municipality has a suitable size for this type of training.

disabled person who needs ambulance for being moved, but at that moment that person is not in the town. The authorities before sending the rescue service will contact the field referent to know what kind of rescue it is needed. This allows to rationalise as well as to strengthen the resources Alessandra Ronconi (ANCI Umbria)

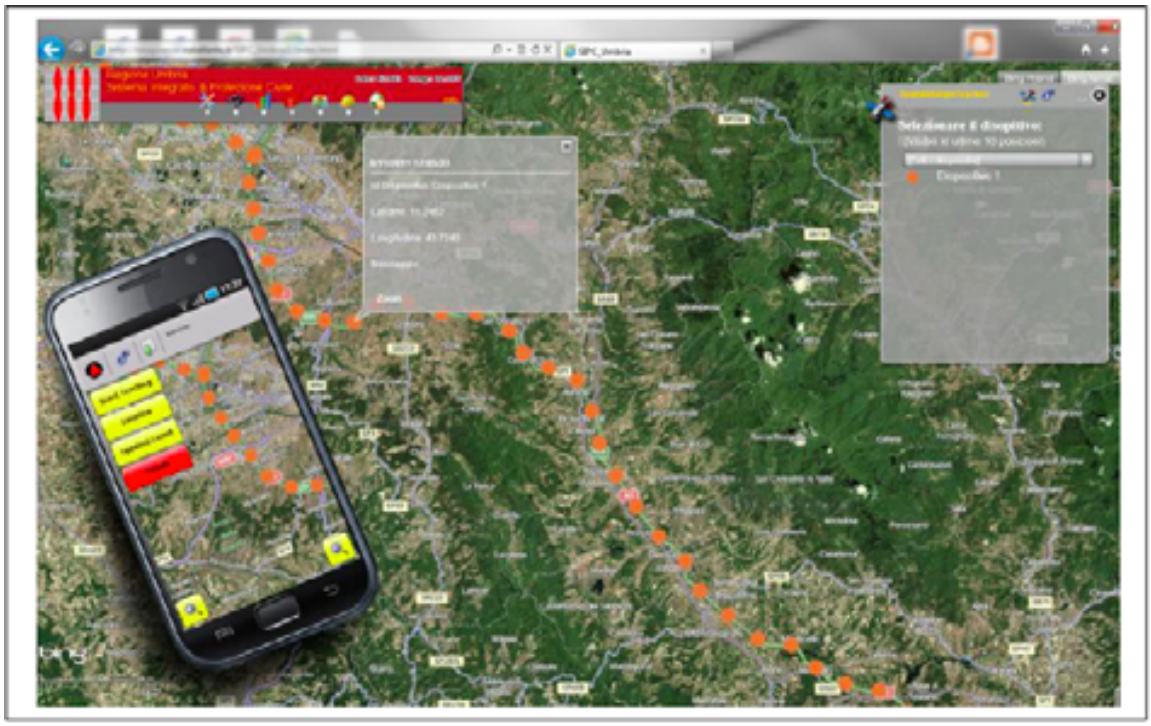

Figure 24 - S.I.S.M.A. project "citizen as first rescue"

Emergenza Umbria

Emergenza Umbria is composed by three parts:

- Cartographic section: it deals with the sharing of the Emergency Local Plan, where data are made available for locals. The map is based on GOOGLE Earth images and gives to the users the main information of Emergency Local Plan structured in layers showing points (eg, assembling points) linear (eg roads in flood risk) and polygonal (eg hydraulic hazard areas) zones. The user can switch on or off layers in order to display the information he is looking for.
- News section: it shows the territorial information about each municipality and the news about risks, reporting the daily Regional Civil Protection centre warning on risk level for each zone.
- Multimedia section: it includes videos and links on weather forecast and educational material. This part is mostly dedicated for training in schools.

The innovative element is the improvement of accessing to knowledge and a new relationship between institutions and population that are more aware of risks and have more opportunities of self-protection. The Web-App is not only a container of news and alerts but it is a tool for citizens to take on a proactive behaviour during the emergency.

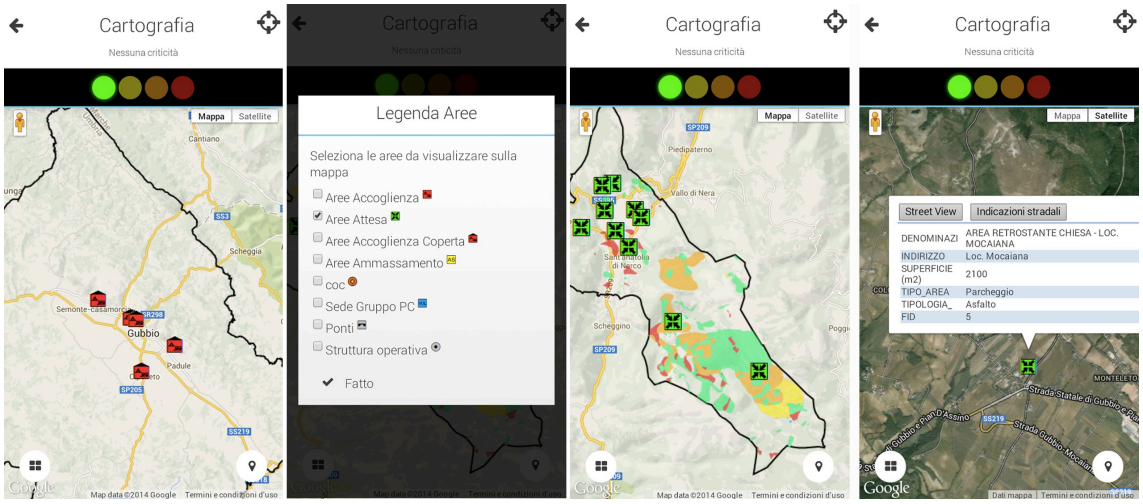

Figure 25 - Screenshots of Emergenza Umbria App

3.2.6 Towards territorial knowledge system

When a disaster or a emergency occurs, it is crucial to collect and analyse volumes of data and to distil from the chaos the critical information needed to target the rescue mission most efficiently. For this reason, the interest of this thesis for the Regione Umbria experience concerns the effects of the introduction of AZIMUT system, an integrated geographic information system that collects and shares data in civil protection field. In particular my interest takes into account the role of this system on the governance processes and on the creation of a common knowledge among different authorities. As already argued in the methodology section, the aim is to investigate the role of knowledge, its relation with action and the effects on the actors network and on PPRR chain.

Each emergency requires information flows between different actors, physically located in different places. The knowledge management (KM) approaches essentially make use of organisational concepts and suggest arrangements that promote knowledge creation and knowledge transfer. Despite the fact that KM is not very common among public authorities, many of the required elements for KM were remarkably present. Thus, the question is rather than if these KM elements revealed any interesting and/or unlikely effects in the governance processes and in particular in the field of spatial planning. The case descriptions have already mentioned some of these findings, such as the type of data, the tool for sharing them and the process among authorities in doing it. In the same way, some elements have been already reported about new actors like the specialists of ANCI - that can be seen as facilitators between scales - and the new role and the new awareness of the citizens in civil protection matter. Despite this, many other issues can be analysed and break up towards the aims of the research.

However, in the next session a deeper analysis of some features will be taken in order to start answering to the questions that were formulated on this research.

But first of all, it has to be assumed that Regione Umbria has a simplified jurisdictional system in the Italian context. As already argued, it concerns only two Provinces and 92

municipalities and it means that even if there is a several number of actors involved in risk and emergency management this is not as much critical as in other Italian regions[67]. In my opinion, this clarification is important because I believe this element has contributed to the project's success. The number of actors involved at different levels increases the complexity of the system.

The role of Knowledge

During the interviews all the actors pinpointed that the objective of the project was the knowledge of the territory towards emergency management and in particular the best way to share this knowledge. The choice was to begin with the data and the information included in the Local Emergency Plan (PCE) because:

- The plan is compulsory for all the municipalities and it has multilevel uses. The plan is elaborated at local scale, but the end-users are many at different levels. Thus, it has a multilevel function: different actors with varied skills need to consult it and, for this reason, the plan also represents a coordination tool.
- There were already guidelines for the plan elaboration. These guidelines suggested a first structure also for the database and they identified what kind of data and information would be useful for the PPRR chain.
- The common structure for the plan was also the opportunity to give priorities in data collection. In the same way, it gave the possibility to add complexity or to simplify the framework according to the needs and the scales of analysis *"(…) at beginning there were more than 80 different types of forms according to the support function of the data. This was the reason why we decided to give suggestions on which data have priority (in collection and in updating), whereas, other types of data could be collected in a second phase (e.g. Pharmacies) because useful but not essential."* Barbara Montanucci (Provincia di Perugia) This choice allows to have a first common mapping of the basic resources available in the Region.

We could claim that the aim of the project was to introduce a knowledge management process trying to codify knowledge in order to guide the rescue activities. As it will be discussed later, this is true but more elements must be taken into account. From the interviews, in fact, it has emerged also the necessity of creating a common ground of knowledge, a sort of common awareness about risks and also an unambiguous language among the different stakeholders (policy makers, practitioners and citizens) who interact across the scales in a dynamic system. It is important to underline that the request of a common language is a subject of interest also for authorities mostly belonging to the civil protection sector but at different levels. In the same way it emerges also the opportunity for a better cooperation with other sectors like spatial planning.

[67] It must be considered that there are other Italian Regions with a much more complex framework. For example, Regione Lombardia has 12 Provinces and 1531 Municipalities. This is not insignificant as the complexity of actors network can have negative consequences on the governance processes.

The common ground between spatial planning and emergency planning is the knowledge of the territory. This knowledge allows you to take the right decisions both on the planning and on the civil protection point of view. (…) The two tools are closely related to each others (…) For the hydrogeological risk the Italian law already found a common ground between the two branches of knowledge, the objective in our case was to find out how to create and acquire the knowledge of the territory (…) Maurizio Tesorini (Regione Umbria)

From the interviews it emerges that the authorities knowledge in the PPRR chain is characterized by cross-scale interaction especially in terms of jurisdictional scale as well as in term of time scale[68]. For this reason, it can be assumed that the authorities recognise - as argued by Cash et al. (2006) - the problem of "*knowledge as a scale*" and the necessity of a progressive inclusion of different data and information. However, the knowledge challenge in the case of Regione Umbria is taken mainly in terms of tools for archiving and sharing it.

The databases become fundamental because they contain all the components of the plan that need to be known. On one side you can know where the resources are, but you can even know what are the needs for that specific emergency. I think that Azimut has given a new multiscalar point of view. Because you can plan in advance where deploying the resources and the total plans' mosaic takes shape helping to identify resources allocations when not available in a specific municipality. This simplifies the job during the emergency and puts on relation the different municipal plans. Maurizio Tesorini (Regione Umbria)

However, another element of interest concerns the role of Municipalities that had been considered the main holders of the knowledge because of their responsibilities in collecting data and information as well as in updating them. Data at local scale, in fact, have a better resolution because of their drawing scale. But in this case, Municipalities were involved only in a second moment when the data to be collected have already been chosen. This critical aspect was just in part recovered during the process of data collection when the upper levels understood that, especially in small municipalities, the technicians can be often holders of tacit knowledge.

Improvement of tacit knowledge transfer

We can consider this enhancement both in the acquisition of new skills at the local level (agents acknowledge new technological methods and models) but even more in the transformation of part of the tacit knowledge into explicit knowledge. Tacit knowledge in this case concerns the acquired knowledge of people who know territories because they live there since long time and they already understand the "territory behaviour" during emergencies. The tacit knowledge concerns the practice, and it can be captured and transmitted when the knowledge holder joins an operative network. As it was already

[68] The time scale corresponds to the PPRR chain, otherwise, it can also be considered like divided in "*before*", "*during*" and "*after*" the event.

discussed, tacit knowledge is not easily shared. It consists of values and mental structures which are deeply ingrained in us and which we often take for granted. Tacit knowledge can be considered a cognitive dimension that shapes the way of perceiving the world. In the Regione Umbria case, the tacit knowledge concerns the idea of civil protection and the connection to its activities. If we look at the field of knowledge management, the concept of tacit knowledge refers to a knowledge possessed only by individuals and difficult to communicate to others. Therefore, an individual can acquire tacit knowledge working together with other experts exchanging *"know-how"*. Tacit and explicit knowledge are not separate and discrete in practice; their interaction is vital for the creation of new knowledge.

The Azimut project, at first sight, is a means of codification for explicit knowledge already held by authorities in charge for civil protection, in order to have a better management of the information. It involves ensuring authorities access to what they need; important knowledge storage and review, in terms of updates or discards. In the theories of knowledge management, in fact, explicit knowledge is found in databases, documents and notes.

> (…) *especially in the small municipalities, that are the majority in this Region, the persons in charge at the local level have a deep knowledge of their territory and maybe they do not use the Azimut database at all for data consulting. This tool is, however, fundamental for all the external actors that intervene during the emergencies or that must have an upper local approach.* Utilio Nasini (Provincia di Perugia)

Despite the codification of explicit knowledge, in the Regione Umbria experience is possible to pinpoint also some elements that can be attributed to tacit knowledge inclusion. Tacit knowledge, in fact, is found in the stakeholders minds and includes skills, capabilities and expertise. The first element that brings back to tacit knowledge concept is the strong link with practice. The Azimut project aims to improve the practice (rescue service activities). In the same way, the project has concerned different phases characterized also by the feedback of the previous stages. Thus the second element referable to tacit knowledge is the interpersonal activities. Barriers to knowledge share and communication were identified in the process and discussed to be demolished. The main example is the introduction of a new actor, the ANCI expert, whose role was to improve the skills of the local technicians increasing their awareness of civil protection. It must be said that this was an unexpected effect of the project. All the persons interviewed stated the benefits of collaboration and feedback loops even if it was not planned but it had become necessary to overcome the problems.

> *Nowadays we can declare that municipalities are more aware of emergency planning than before. We must consider that usually in small municipalities the technician in charge there is only for one or two days per week. Indeed, with the ANCI experts' job we have improved the skills of the technicians, because they work together, they interact and they create a*

new network. Nowadays these technicians have acquired new knowledge towards a civil protection prospective; this is the benefit of this experience. And, in fact, when there is an event, most of the technicians use to call the referenced expert because she/he represents the first contact with the upper levels. Maurizio Tesorini (Regione Umbria)

I like this project because it was a chance to create new flows of information and networks. We have enlarged our networks with other sectors that have direct or indirect linkings with civil protection. And nowadays we work together: we share information as well as common solutions sitting at the same table in order to evolve together. For example, someone is able to collect some data, while, in another sector can be reached other information, so we cooperate. Barbara Montanucci (Provincia Perugia)

Building trust and increasing self awareness of responsibility.

The experience of AZIMUT has increased the network skills of the different institutions involved. The concept of networking was one of the main aims of the project, but only the practice has caused a really improvement of the cooperation ability of the actors. At beginning the AZIMUT system was ~~a~~ top-down decision based and, indeed, during the first phases there were several unforeseen difficulties to solve. In particular most ~~of~~ municipalities, especially the smallest, did not have agents with the proper skills for doing the data collection and updating. Some of the municipalities did not use information technologies, and in some cases there were not computers available. In this framework the Project of Assistance for the Municipalities made by ANCI experts contributed to the success of the AZIMUT project, improved the empowerment of the municipalities agents and built mutual confidence.

Nowadays there is only one tool for collecting and sharing data and one unambiguous way to make the emergency plan. And the positive thing is that the process that led to this result had also increased the confidence among the actors involved in emergency management. Barbara Montanucci (Provincia di Perugia*)*

At beginning when we [ANCI experts] contacted the municipalities the technicians were wary and they did not trust in us. As time passed by, we started to know each other, we demonstrated our readiness and competences and they also taught us a lot of things. We started to cooperate (…) Nowadays technicians and mayors use to call us before the Province or the Region. For instance, if they receive some new requests from the upper level authorities they use to contact us for support. We earned their trust! It was not a foregone conclusion. Alessandra Ronconi (Anci Umbria)

It started as top-down project but now there is a change of course. Nowadays the municipalities contact us for asking support. Maurizio Tesorini (Regione Umbria)

This aspect had great benefits especially at the municipal level because the AZIMUT system improved the skills and competences of the persons in charge. The phase of collection and the continuous updating demand incentivize the creation of specific local and provincial offices, dedicated to this task. These technicians will be the incumbents of making all the information and data available to the emergency managers during the event. At the same time, the usage and the acknowledgement of a unique tool throughout the Region – where the data are codified in the same way and with the same meaning – improves the cooperation among people who, during peace time, use to work in different places but have the same job assignments. During disasters, the cooperation among different territories is common. If experts share the same tool for creating and consulting knowledge they can easier reach the data and information they need with a reduction of time and a faster response.

> *The choice of an unambiguous procedure for the emergency plan gives a working method to technicians. This also represents a benefit during emergencies because each technician is trained to work everywhere. For instance, if a municipality has an emergency it is easier to give support. In each plan the contents are different but the working methodology is the same.* Maurizio Tesorini (Regione Umbria)

Part of this success of the project also regards the absolute clarity of responsibilities. As it was already argued the PPRR chain is characterized by an enormous number of actors involved with different responsibilities. The section about the Italian legislation (3.2.1.) underlines how the Italian system is still suffering of a fuzzy framework, especially in practice. In this case, part of the project tried to clarify this situation with benefits on the organizational ground.

> *Nowadays there is an organised response capability in the municipalities never seen before, in the past this capability was much more fuzzy*. Paolo Ciaccasassi (Regione Umbria)

Land use planning

The physical planning or land use planning is regularly given an important preventive role on safety and it is a criterion to decide where and how to build structures in most of the European countries.

However there is still little knowledge on how the structural planning can be related to the emergency planning. A correct structural planning, should take into consideration the presence of elements of hazards. The new approach of Regione Umbria tries to change the concept of hazard towards the idea of resilience. In this sense the emergency planning seems to give suggestions on how to change the elements of urban districts in order to consider the systemic vulnerability and to increase the resilience of the system. What it is important to underline is that the Region changed its point of view for hazard and risks, from the "building scale" to a " systemic scale" where the relation between elements are

important as much as the building resistance. It was introduced the concept of minimum urban structure for recovery and preservation. The minimum urban structure concerns all the functions, itineraries, strategic places and buildings that must be preserved so that the ordinary urban activities can continue in order to support the response and the recovery after the event. This structure is composed by three different systems: infrastructure and mobility, public services and buildings. The awareness of the minimum urban structure influences not only the response phase, but also the prevention policies and in particular it must shape the development of urban choices. As Maurizio Tesorini underlined:

> *An efficient urban planning should take into consideration the critical elements of its territory, thus, it must have acknowledged the existing risks. Usually, spatial planning covers mainly the concept of hazard and far less the concept of vulnerability. This is the reason why we decided to introduce the concept of minimum urban structure that considers the interrelations of the elements, and evaluates the direct or indirect relationship of vulnerability among the elements and the effects that the fragility of a node could produce in the overall functioning of the whole system. (…) there are elements, like historical heritage, that are important for urban planning as much as critical for emergencies planning (…) The minimum urban structure allows to identify the most critical elements for the system and the most decisive elements in the management of rescues. (…) This is the reason why it is important to understand - especially on the building stocks - which tools (e.g. structural plan, local emergencies plan) are malleable in order to make the urban system more resilient.*

Involvement of population

Population at risk is another important aspect to be taken into consideration. The approach to community behaviour towards risks is different according to the PPRR chain phase. In particular, in the last decade the main progresses have regarded the prevention phase especially in mitigation actions. Especially the concept of sustainable development and the Agenda 21 projects helped in this aim, however, there were not the same progresses in community resilience during emergency. In the Italian framework the involvement of population is required by law (112/1998), but most of the time the concept of *"commander and control*", in which people are passive actors to take care of, is still in use because of their low competences in rescue service and because during calamities they are exacerbated by frail psychological status.

But, as we already argued in Chapter 2, the people are not passive elements. They can also have an active role during emergencies: they could be a source of risk - e.g., misbehaviour may increase the risk factors – or they could be important in handling risk, e.g., people could warn off dangers or could search information in order to save life and properties. If we look at resilience like a world where the abilities of its multi-stakeholders interaction, included citizens, are fundamental in determining the dynamics of the system we can understand that also citizens should have responsibilities in avoiding the collapse of the system. Resilience implies a change in the way of doing policy, planning and

governance and it implies a change also in the participation of people. Once again, there is the necessity of a new civil protection perspective that maximizes the resources of the system and that people must also be made aware of.

> *Civil protection means having a plan of what to do. But it doesn't mean that only authorities and civil protection have responsibilities but also citizens should know the crucial elements. And this gets the concept of resilience. Resilience has two main guidelines: the first one regards the resistance of infrastructure and building, but the most important is the capacity of society to react and survive to the traumatic event and not to collapse. (…)Working on urban vulnerability means acting on all the elements of the urban system and citizens are part of these elements. People are not sacks of wheat, they have their own dynamism. (…) We should increase citizens' response capacities to emergencies because this influences resilience.* Maurizio Tesorini (Regione Umbria)

Regione Umbria uses two different methods to reach this goal. The first one concerns the education of citizens. In the past this was already done especially in the schools or in public events, but today it is enforced by the web. The use of social networking can have several benefits. Mobile apps are channels which customers can access at a time and place of their choice, which they understand and are comfortable with. It can offer a more open and transparent relationship between customers and councils and offers new ways of involving citizens.

The second method is more innovative because is based on a proactive role of citizens. Volunteer rescue workers can use smartphones to collect and share information about the situation on field. This can be very important because it allows to allocate rescue resources in terms of place and type and kind of problem to be solved, i.e. if roads are still usable for the transports etc.

Thus, the potential of social media is great. They could be used to share information but also to get spatial data from citizens, therefore public administration should not lose this opportunity.

3.3 Comparative analysis and empirical findings

In Chapter 1 and Chapter 2 came to light the key elements in order to manage resilience in social-ecological systems towards natural hazards. Social-ecological systems are defined by uncertainties and by multiple- and cross-scales dynamics (of the ecological sub-system as well as the social sub-system), at the same time they are characterized by the relations and interactions between individuals, societies, groups and institutions and by adaptive cycles (ecological, social and economic processes that permit the continued adjustment and self-organization of the social-ecological systems)(Adger, 2000; Anderies et al., 2004; Berkes & Folke, 1998; Cash et al., 2006; Gunderson & Holling, 2002; Gunderson et al., 1995).

Both case studies are example of social-ecological resilience (see 1.2.2.) focuses on cross-scale dynamic interaction and learning capacity (see 2.1.3, 2.2.2. and 2.2.3). Nevertheless, there are some differences between the two cases. In the Swedish case the adaptation actions of diverse sectors have an important role, whereas, in the Italian case the technology play a crucial role.

However, the analytical categories for the case studies have been defined in order to investigate the capacities needed to manage resilience and because of four elements of the organizations, institutions and knowledge systems of the case studies were taken into account:

- Scale: to engage effectively with and handle and cross- scale dynamics
- Uncertainties: to anticipate and cope with uncertainties and surprises
- Knowledge: to combine and integrate different form of knowledge
- Institutional flexibility and learning capacity (networks of information and access to information)

3.3.1. Cross-scale

Both the case have demonstrated their awareness that more consciously address scale issues and the dynamic linkages across levels are more successful at (1) assessing problems and (2) finding solutions (Cash et al., 2006).

Both Swedish and Italian risk management systems are cross-scale issue; all the levels are involved from national to local and, at least by law, they should have interaction and a continuous flow of information in an embedding process; but usually the different institutions do not have collaborative linkages.

One of the key factors of the success of the two case studies was to include social factors such as learning, trust building, sense of making, conflict resolution because they are crucial for the success of the resilience approach. The cross-level linkages develop to access information have provided benefit to linking agents through the use of these information.

3.3.2. How knowledge is built

The knowledge creators as well as the practitioners have different worldview and they should find a common conceptual frame (Roux et al., 2006). The case studies adopted different methodologies to build the knowledge system.

In Kristianstad the flow of knowledge has a structure made of information exchange and reporting that should favourite the feedback loops at different scales. This method, prescribed by law, has the ambition to embedding the different information and knowledge but there is not a clear method for collecting and elaborating the data and information with negative consequences on the decisions.

Indeed, in the Italian case the knowledge infrastructure is crucial for the project Azimut. The database is the core of the knowledge system: there is a strict structure of the database, where the data were selected and collected in a fixed way. In the same way, all the creators and the users has acquired the ability for using the software and share a unique definition for the different information. We can assume that the Azimut project has lot of elements typical of a knowledge management approach. This does not mean that there is not problem with the use of the software for collecting and managing data. The definition of the data to collect, the cataloguing and, in particular, the updating ask long time and technicians. Anyway, it is important to highlight how was strategic the idea of starting to collect the information useful for the Local Emergency Plan. It allows to have a first common group of data uniformed on the regional territory, and at the same time, it has given inputs to cross-sectors collaboration (e.g. heath sector and planning sector).

3.3.3. The role of knowledge: networks and building trust

The knowledge applied in the two cases is network knowledge. The networks among stakeholders are important for accessing and combining the knowledge to match systems structures and processes scales. Networks play a crucial role in the dynamic relationship between actors. The different actors have diverse background and consequently they have diverse perspective used to recognize and solve problems. Without the construction of a common conceptual space for the different domains the potential solution is threaten. In this framework, the dynamic relationship among actors plays a crucial role in the process of knowledge system. In both the cases, the main outcome of the actors' interaction is the creation of a community of practice (Wenger, 2000). In the Italian case the community of practice is create intentionally with the goal of gaining the knowledge for the Emergency Local Plan and with the support of technological infrastructure. Differently in the Kristianstad case the community of practice seems to be an unintentionally.

Both the communities of practice created are based their success on the trust building. Trust building processes are important for mobilizing people involved in the network and creating vertical and horizontal linkages. It is fundamental for collaboration because a lack of trust can be a barrier to the emerging of collaborative arrangements. This is manifest in the Italian case:

> *At beginning when we [ANCI experts] contacted the municipalities the technicians were defensives and they did not trust in us. As time passes, we started to know each other, we demonstrated our readiness and capacities and they also teach us a lot of things. We started to cooperate (…)* Alessandra Ronconi (ANCI Umbria)

However, both the cases required long periods for trust building but finally it is one of the most successful elements. Regarding the embankments project in Kristianstad, Anders Plåsson argued that "*We discussed what do to from 1995 to 1999. (…) Only in 1999 there was the decision of the Mayor to start the protection of the city and the project started in 2001"*. During the six years before the realization of embankments the group earned its credentials and improved the awareness of the flood risk at the local level and changed the local political agenda. Also in the Italian case trust building required long time and it was made in two different steps. The former was in the elaboration of the Azimut structure between Regione and Provinces, than, the latter regarded the involvement of municipalities. It is important to highlight that only in this second step the upper levels understood the gap of competences of the municipal technicians and for in reason of that included a new actor (ANCI) as mediator.

3.3.4. Key actors

Regarding actors the two case studies shows the presence of new interesting key actors. This is manifest especially in the Swedish case where in the different projects emerged always a key organization that facilitates cross-scale interactions. Both Ecomuseum Kristianstads Vattenrike and the risk group had a key role in the success of the projects. Regarding the natural conservation and environmental protection is important to highlight that the EKV is a bottom-up group that was born on local initiative and a self-organization process. It has no authority and power and this has given to it more flexibility in building networks and actions. Otherwise, the risk group is composed by technicians come from of two different sectors: two persons from the local rescue service and two from the municipal technical department. As EKV, they play a role of coordination, mediation and accountability between the different stakeholders involved.

In the Italian case, ANCI technicians play this role. They are not a legal obligation and it is the first time that they are used in Italy, but they revealed a key role in the translation and mediation between municipalities and upper levels.

The success of these organizations seems to be the capacity of "mediating" the knowledge that usually is held, stored, and perceived differently at different levels. This type of actors are called by Cash et al., (2006) *boundary organizations* or *bridging organizations* because "*they play a intermediary role between different arenas, levels, or scales and facilitate the co-production of knowledge*" (ibid pp. 8). They do not only combine knowledge but also to interpret and make it accessible in the local context. Throughout their role in the process they can synthesize and remove the shift of knowledge between the different levels and scales. They establish functional links within and between levels and facilitate the flow of information and knowledge applied in the local system management. What arises from both the case studies is the fundamental role of these actors in the processes of building trust, compiling and generating knowledge. Their role is characterized by:

- Accountability to all stakeholders involved.
- Trust building.
- Translation.
- Coordination and complementary expertise
- Mediation
- Leadership

As Olsson, Schultz, Folke, & Hahn (2003) argued the EKV was instrumental in leasing a transformation into the area management and represented a "window-of-opportunity" for change. In particular, trough its facilitator role has extended the networking by linking different knowledge and experiences. This role created a connection between different levels and was crucial for building adaptive capacity and resilience (Berkes et al., 2003; Gunderson & Holling, 2002).

3.3.5. Social-response

Both the case studies have worked on the population's awareness of risks as well as it can assume that the social memory of past experiences have played an important role in the collective sensitiveness of the problem. In the Swedish case the flood risk is a permanent problem that reappears almost every year, while, the last "big" earthquake in Regione Umbria was less than 20 years ago followed by other two devastating earthquakes in neighbouring regions. The social memory seems to play an important role in the self-organization process and key individuals drive this knowledge across the scales. In this sense the collective learning process evolves as a part of social memory. At the same time the two cases show different aspects of including people in risk management. The Swedish case does value to a bottom-up approach, in fact, the EKV was born by different organizations and citizens that observed the gradual decline of natural environment. This case shows also the multi-disciplinary interest of people to the environmental field, from ecological issues to risk management. Also it shows how there is an emerging interest by people to be involved and the increasing attention to the environment. Nevertheless, the authorities seem unprepared to support the requests of inclusion and overlook the potential of citizens' inclusion. They underestimate the effort required to include citizens in resilience.

> *"We involved people in different ways: with workshop, with public discussion. Thus we interact quite a lot during planning and the planning review and I don't think we have problem with that. (..) I think is very important through media and trough all municipal channels to inform citizens that this is an area with high flood risk and if it something will happen the rescue service will give them information about how the situation is and how the private persons should fellow the different steps."* Margareta Lannér Hagentoft (Planning Department Kristianstad Municipality)

Indeed, in the Italian case the authorities betray more attention to the citizens' role during emergency. It emerges the potential proactive role of individual that can improve their knowledge in handling risk through the awareness of the crucial elements of civil protection. The awareness of citizens' key-role in building resilience is well know by civil protection authorities that intentionally have decided to work on it. *"Working on urban vulnerability means acting on all the elements of the urban system and citizens are part of these elements"* (Maurizio Tesorini, Regione Umbria).

In this field the Regione Umbria has introduced important innovation toward the proactive role of volunteers. The S.I.S.M.A. project shows the potential of web, smartphone and social media in the rescue field. However it is important to underline that such of innovations (in particular the selected volunteers that collect and share information about the situation on field) have many problems in term of data quality and accuracy.

At the same time, the Italian case shows the potential application of these technologies in small town with few number of population, whereas, it is more difficult to support the

same approach in a city. This is a limit but at the same time an opportunities for marginalised area, where the rescue activities are slower and more difficult and where the community use to have a better interaction.

4. CONCLUSIONS

The aim of the last part of this thesis is to sum up the research course and to identify relevant trends and features. The first part concerns the research questions in relation to the case studies. Differently, the second part considers the methodology applied and future directions for research.

4.1. Planning for resilience

The main question of this research is: *What are the challenges that planning is facing in the increasing uncertainty?* In the incoming decades, there will be an increase of uncertainty in the context of world "risk society" (Beck, 1996, 2009) where society becomes more interdependent and more complex (in term of rapid urbanisation, uncontrolled use of land and exploitation of the resources), thus more vulnerable to new threats and risks (see 1.1.1.). In such a framework the core value of planning is a constant search for knowledge to provide certainty toward a predictable tomorrow. Thus, the concept of resilience can help in planning, and in particular in risk management, looking for new solutions and approaches. Even if the term resilience is still "fuzzy" in planning, the analysis of the concept in its social-ecological approach shows challenges and opportunities for planning (see 1.2.1, 1.2.2, 1.2.3).

In the first part of this research (see 1.2.2), the discourse was about the characteristics that allow the use of the concept of social-ecological resilience for urban systems: (1) humans as part of the ecosystems; (2) urban system as a complex system because of the sum of several subsystems in interaction; (3) the ecological, social and economic processes as adaptive cycles that permit adjustment and self-organization of the systems in order to find "new orders".

Therefore, social-ecological resilience analyses how ecosystems are structured and behave and the way institutions and the individuals associated with them are organized and act. In particular, concerning the adaptive cycle, resilience concept focuses the attention on processes and dynamics function where the individuals, groups, and institutions play a strong role. Social-ecological resilience is linked to the necessity to learn how to manage issues through change rather than simply to react and which is the key role played by individuals and small groups or teams in this context.

In this scenario, two main issues emerge: (a) multiple distinctive scales with cross scale interactions (panarchy), (b) individual, groups and institutions responsible of the interactions. In this way, resilience implies a change in the way of doing policy because it highlights the need ~~of~~ for flexibility, moving from being rationalist or bureaucratic to become more adaptable and collaborative. In this way, the resilience concept considers dynamism as an intrinsic factor of how system act and for this reason it draws an alternative perspective of planning, as more dynamic, fluid and interpretive – because

partially structured by shared procedures and norms- that are adaptable to changes or uncertainty and help managing them.

Despite the fact 'uncertainty' decisions still have to be made, planning knowledge is a decision-making tool considered as essential and directly relevant for risk society. Planning in risk society context requires leaning on all forms of knowledge e.g. expert and non-expert, as well as identifying and sharing them, in terms of having risks perceptions shared with a wide range of actors. The resilience concept, even if concerning the question of responsibilities, tries not to see the action as a bureaucratic process but is more in favour of a shared vision. In order to do so, stakeholders must build a common conceptual space for different domains, even if nowadays there are different perspectives, due to the pluralism of professions involved and the scale chosen for the observation of the phenomena. Nevertheless, the challenge of flexibility and dynamism in planning sets also a challenge of dynamism in the knowledge systems and learning process that are the main tools for the interaction among actors and scales.

The empirical work done in this research was important to understand how institutions effectively are engaged with the externalities of the unknown and which are the areas of collaboration between different actors that strengthen resilience in facing uncertainty. Similarities and differences between the case studies were already highlighted in the previous chapters (see 3.1.7, 3.2.6, 3.3). Then, considering the vast theme some reflections can be proposed. In general, risk management is recognized as a cross-scale issue including a pluralism of professions working at different levels. The interaction between scales is intrinsic both in planning theory and practice. Nevertheless, in the field of practices, the tools (norms, procedures, plans) that should support interaction suffer of several limits. Most of the time, the interaction underestimates the need of a common significance framework, as well as the difficulties in having feedback loops between different levels. Both the case studies started their projects and processes with this awareness and have worked in overcoming these difficulties, in particular working on their knowledge systems and learning processes. Therefore, this was the main interest used selecting the case studies of this research. Furthermore, the two cases were selected also in reason of their different approach, one more focused on the use of the technology, the other more oriented to the development of learning processes. However, both the cases outlined a convergence of reflections. First of all, building networks and knowledge systems require the willingness of the individuals to cooperate. Once more the key role played by individuals emerges, as it was recognized also in the resilience theory (Folke, 2006). The willingness of individuals in building a community of practice needs building trust processes and strong leaderships able to direct without impositions the community~~'s~~ members. Policies and initiatives are strongly linked to the individuals. The abilities and skills of actors produce good practices, experimentations, and improvements, etc. The creation of communities of practice (Wenger, 2000) enhances the knowledge system, increasing the shareable know-how, because it incentives the union of tacit knowledge and practical experience, otherwise unexpressed (see 2.2.4).

Other reflections from the practice are:

- Increasing of the self-awareness of responsibilities. The creation of formal/informal communities of practice clarifies and makes the different roles and responsibilities explicit due to stronger accountability.
- Technology can be a helpful tool for supporting the creation of a common significance framework. Software and tools like GIS require rigid definition of the information, they can help in knowledge codification. In the same way, they allow to add complexity or to simplify the framework analysed according to the scales of analysis, with a major flexibility to different situations.
- Citizens play a new important role in resilience approach. They become part of that group of individuals that resilience theory recognizes as fundamental. They can play a proactive role and there seems to be a great intention from the bottom to be involved more and more.

On the contrary, practical experience has shown also the limit of resilience approach based on knowledge sharing and learning processes. Firstly, building a solid knowledge system concerning both database and strong actors' network requires time. Time for collecting and building database, as well as time for accountability and building trust with all stakeholders involved. Stakeholders and actors have been working on their own system for, at least, ten years and in the future a number of improvements must be made (data updating and enlargement of database). Thus, even if sharing knowledge is a desirable approach it could not be the only one. Nowadays, the territories are exposed to growing pressures, in many cases there are territories suffering permanent hazards that need solutions in shorter time. Building a solid knowledge system able to produce self-learning processes can be a long-term strategy, but it is not acceptable in short term. For example, in the Swedish case the long-term strategies of risk perception, environmental protection and social-learning process were accompanied by structural measures like engineering works and planning and housing norms.

Furthermore, the practice highlights the need of a clear path in learning processes and building knowledge. The activities from the case studies led to subsequent communities of practice, but these communities were born unintentionally during the process, including new actors, in order to ensure the success of the activities.

Lastly, also the citizens' involvement shows some limits. In general, citizens can be mostly involved in order to give or to be educated on how handling risk. Much harder is gathering information in terms of data quality, accuracy and integrity. However, it is a field in continuous expansion whereas crowd-sourced spatial data have just started. However, the Regione Umbria case study demonstrates the potential of using data collected from people in small towns or remote areas. Anyway another limit of citizens' involvement concerns how to attract the citizens' attention, especially in those areas characterized by hazards with long time return.

4.2. Reflections on methodology and future directions for research

At the end of the PhD research path, the methodology can be easily questioned. In this research there are aspects which could have been considered or better integrated. First of all, climate change and adaptation policies (see 1.3.3) were not considered as a key-concept of the analysis. In truth, the starting point was the idea that natural hazards not necessary relate to climate change (for example earthquake risk). However, these aspects could have a stronger integration with uncertainty planning because they can bring out elements related to trends and approaches.

Room could be also made for people's risk perception. The dissertation gives special attention to the citizens' participation in resilience (see 2.2.5), but does not carry out a deep analysis of risk perception especially related to the risk culture, the demand for safety and the security society. Consequently, it could be of interest analysing the implication that security policies can have on the promotion of extraordinary power that can suspend the regulations in force. In the field of urban studies these practical issues are usually studied by sociologists and lawyers, therefore this research theme opens up to various disciplines.

There could also be a wider analysis of the citizens' role in relation to social media and networks. This is a growing field full of potential but that hides also several problems.

Another important clarification has to be done regarding the case studies' scale of analysis. The analysed initiatives, even if they concern the cross-scale interactions, were focused especially on local and regional strategies and policies that have been taken, whereas national and European directives had less importance in this dissertation. In this framework, it can be important to understand how national and European strategies can influence the policies and actions at lower levels.

Furthermore, a limit of the research is the exclusive attention given to environmental and civil protection policies while less importance was attributed to others sectors that can have implications in terms of pressures, resources, skills on risk management.

In the same way, the research can be improved on the research method including interviews and analysis of citizens on they risk perception and the changes of the perception according to the extreme events and new policies.

Leading the research to a possible new beginning after this thesis, the first recommendation would be to broaden and consider these aspects. On the other hand, regarding the research field, there are specific aspects that can be analysed in order to continue the study of this topic. A particular attention should be given to the way to integrate "resilience thinking" in urban planning. If resilience concept has already been appealing especially in the environmental and climate change issues, there is still a limited use of the concept of resilience in urban planning. The term resilience should find its way to be introduced in the plans and processes of spatial and urban planning. Both changes in society and in hazards have impacts and demand new ways of handling the growing uncertainty. Socio-spatial interactive process is central in planning practice made to create urban habitat (Friedmann, 1987), this process can play a vital role in communicating risks

and resilience elements from wider social networks to counter threats. In this respect, several models of planning inspired by communicative planning theory (as developed by Habermas, 1987) that emphasizes communication in a socio-spatial interactive process to create urban habitat), are relevant e.g. "collaborative planning" (Healey, 2006) "consensus building" (Innes & Booher, 1999); "shared decision-making" (Gunton, 2003); "co-management" (Rao & Geisler, 1990); and "deliberative planning" (Forester, 1999). This research suggests risk and uncertainty are used as 'key attributes' to the development of a new path of planning for resilience.

Another interesting subject is the role of private actors in safety. Public or private stakeholders that nowadays are usually not involved in sharing information and knowledge and can have interest or can be "special observers" of the territories. For instance, insurance companies or public utilities can play this role. The magnitude of economic losses caused by natural disasters is growing with critical consequences on the global insurance industry; this is the reason why insurance industry has interests in finding solutions for the natural disaster risk and the societal impacts. In the same way, public utilities can be important actors to be involved because of their infrastructures that cover all the territories.

Uncertainty and complexity can be excuse for not taking action in planning. Uncertainty not 'risk' but should be the basis of analysis for planning to make an uncertain future manageable.

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