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Caged windows of opportunity for the reduction of "natural risks":
urban planning and governance between disasters and resilience in Italian cities

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The choice of dedicating my Ph.D. research to nature-related risks is very personal. Before being admitted to the doctoral program in Urban Studies at GSSI, I took part in a large three-years research of the Department of Architecture and Design of Sapienza University (Rome) about post-earthquake reconstruction in Abruzzo. Such experience was so professionally and emotionally involving that I decided to bring forward my interests and try to give my contribution, focusing my Ph.D. path on studying the challenges of planners, administrators and policymakers addressing nature-related risks in a fragile country like Italy.
I am an urban planner, trained at Sapienza faculty of Architecture: the multidisciplinary and international nature of GSSI Urban Studies Program allowed me to enlarge my knowledge and perspectives in the realm of social sciences, thinking “out of the box” of my previous education. In the same time, my personal technical background has guided my motivation and my research approach: very problem-oriented and context-dependent, focused on the role of research in “bridging” between issues, practices and policies, going beyond outdated boundaries and certainties.

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To Roberto, to whom I dedicate this work (borrowing from Eugenio Montale):

Scendo milioni di scale dandoti il braccio
non già perché con quattr'occhi forse si vede di più.
Con te le scendo perché so che di noi due
le sole vere pupille, sebbene tanto offuscate,
sono le tue.

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LIST OF ABBREVIATIONS, ACRONYMS AND ITALIAN TERMS

Autorità di Bacino	River Basin Authorities
BwN	"Building with Nature" (Interreg Program)
Casa Italia	National Department for the development, optimization and integration of tools for the care and enhancement of the country's territory, urban areas and housing heritage, also addressing the safety-level and energy efficiency of the building stock
Com'era dov'era	"As it was, where it was"
Comunità Montane	Unions of mountain municipalities
D.	Decree
DCDR.	Decree of the Commissioner of the Reconstruction
DLgs.	Legislative Decree
DM.	Ministerial Decree
DPCM.	Decree of the President of the Council of Ministers
Demanio Idrico	Water courses of state property
Frazioni	Hamlets
ItaliaSicura	Mission Structure against hydrogeological instability and for the development of water infrastructures
L.	Law
LC.	Constitutional Law
LR.	Regional Law
NBS	Nature-based solutions

OCDPC.	Ordinance of the Chief of the National Department of Civil Protection
OPCM.	Ordinance of the President of the Council of Ministers
Perimetrazione/i	perimeter/s of the Reconstruction plans
Piani di Bacino	Basin Management Plans
Protocolli d'Intesa	Public interinstitutional agreements
RD.	Royal Decree

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ABSTRACT

The notion of “risk” is expressed as a complex product of several interacting components, such as the probability of hazardous events, local vulnerabilities, exposure to hazards, resilience and community preparedness (Paul, 2011). The thesis examines “nature-related” risks in Italy, a fragile country with a strong propensity to earthquake, landslides and floods. Supporting the call for more proactive approaches to risk reduction instead of post-disaster massively reactive measures, the ambition of the research is to investigate how ordinary urban planning and urban governance contribute in promoting innovative long-term risk reduction and resilience in risk-prone urban areas. Only apparently contradictorily, the thesis uses post-disasters contexts as case studies. Ruinous events are here questioned from a double point of view: on the one hand, catastrophic events are assumed as lens for analysing which are the interrelations and clashes between ordinary and extraordinary ways of intervention for risk reduction, looking at how ad-hoc plans and policies are shaped and implemented; on the other hand, the research looks at if and how disasters act as trigger events, windows of opportunity for enhancing the science-policy interface and socio-technical innovation for reducing the likelihood of future disasters in risk-prone territories (as it should be expected: Birkland, 2006). The author moves from Olshansky&Chang’s statement (2009): “Disasters are not instantaneous occurrences, but rather they are perturbations to urban systems that reflect longstanding environmental, economic and social issues. In turn, they exacerbate those issues in the years following the event”.

The nature of this research is mainly exploratory-explanatory and positioned between the spheres of academic scientific research and planning policies and practices – in their design and implementation, assuming the need to foster the continuum among academic science, local governance and practices. The research interfaces between different disciplinary borders, moving from an urban planning point of view, enriched by disaster studies and political studies, grounded in Italian and international literature. The methodology applied in this thesis is mainly qualitative, based on case studies, investigated through documental analysis, fieldworks, semi-structured interviews with qualified informants, participation in dedicated technical seminars and workshops.

The “Italian Case” is investigated at the national level first through an exploratory viewpoint, retracing the evolution of legislation, policies and strategies addressing risk reduction and adaptation up to the most recent experiences, such as the activities of the national “Mission Structure *ItaliaSicura*” against hydrogeological risks. Secondly, the research addresses two case studies selected for their relevance – the cities of L’Aquila and Genoa – which allow access to grounded dimensions of the key issues of the research. Both cities are characterized by a history of shocks induced by nature-related risks but with patterns and practises of intervention currently put in question. L’Aquila, Capital City of Abruzzo Region, and other 56 surrounding municipalities were severely damaged by an earthquake in 2009, and a massive reconstruction process is still ongoing in the area. Genoa, the 6th largest city of Italy by population, has always been affected by a very high flood risk, and experienced two dramatic floods in 2011 and 2014: large projects for flood risk reduction are currently in progress in the east side of the city. The different nature of risks involving the case studies makes them complementary in the overall aim of the research, with the purpose of keeping a larger point of view (not just hazard-related) on the topic debated.

The ongoing processes in Abruzzo and in Genoa highlight remarkable paradoxes of both ordinary and extraordinary policies, plans, technical norms and funding mechanisms for reducing nature-related risks, from the urban scale to the building scale. A heavy influence of pre-disaster paths, tools and norms (both the existing ones, both the missing ones) in shaping post-disaster choices – able equally to speed up or to undermine the transformative innovative potential of reconstruction processes – arises clearly among the research results: the work done "in time of peace" is a fundamental resource in future "emergency times" (inevitable in risky areas) when the windows of opportunities are compressed in time and space. The case studies demonstrate therefore the crucial necessities to invest in *ordinary* institutions, policies and tools for risk reduction in risk-prone cities and to optimize the science-policy interface in the field, not just for better protecting the territory and augment local resilience, but even for guiding more effectively the future *extra-ordinary* post-disaster scenarios and patterns of intervention.

INTRODUCTION

BACKGROUND: “NATURAL” RISKS, DISASTERS, AND THE CITY.

NATURAL PHENOMENA AND ANTHROPIC DYNAMICS

What is a “natural risk”? Earth is a very living planet, as demonstrated by the very large range of potential hazards that natural environment presents us: rainstorms and wildfire, floods and droughts, heatwaves and cold-waves, windstorms and hurricanes, volcanic eruptions and landslides, earthquakes and tsunamis (Wamsler, 2014, pp. 20-23; Wisner, Blaikie, Cannon, & Davis, 2014, pp. 6-8). A hazard is not a risk, but a component of it, because a natural hazard generates disruptive impacts when it affects vulnerable elements exposed at those hazards: vulnerability and exposure that are mainly the results of anthropic dynamics. Indeed, risk is widely expressed as a complex product of interacting components, depending on the occurrence of a certain magnitude event, the effects on human and natural systems, the local preparedness to respond to the hazard (Paul, 2011).

The main determinants of risk are globally identified in *hazard*, *vulnerability* and *exposure*; in recent times, the concept of *resilience* – intended as the complex ability of systems to cope with a shock to adapting to it – entered in the debate about risk both as theoretical notion and as guiding approach for practices, identifying characteristics and capabilities able to contribute to the reduction of risks (Paul, 2011, pp. 67-111; IPCC Intergovernmental Panel on Climate Change, 2014a, pp. 39-40).

In this thesis, the author assumes the expression “nature-related risk” in spite of “natural risk” – inspired by Wamsler’s studies (2007, 2014) – for stressing the role of social, economic and institutional processes in exacerbating natural potentially harmful dynamics. Especially in the case of risks affecting urban systems – the focus of this dissertation – the anthropogenic components are fundamental elements to investigate for a truthful interpretation of urban risks.

NO “ACT OF GOD”

What is a disaster? Quoting again Wisner and colleagues (2014, p. 5), “disasters are a complex mix of natural hazards and human action”. Research on disasters has progressively enlightened the role of human activities in provoking disasters, exacerbating natural hazards by increasing the vulnerability and exposure of human settlements – even increasing those same hazards. As for risks, it is recognised as scientifically incorrect to speak about “natural” disasters, an expression that recalls the interpretation of disruptive events like earthquakes or volcanic eruptions as “acts of God”, by reducing the risk to the hazard. As stated in UN Sendai Framework for Disaster Risk Reduction, between 2005 and 2015 over 700.000 people lost their lives and more than 1,5 billion people have been variously affected by disasters, for a total economic loss was superior to $1.3 trillion (UNISDR United Nations International Strategy for Disaster Reduction, 2015, p. 9). Data from UNISDR show that both frequency and economic damage induced by disasters have grown extensively since 1980 (UNISDR, 2015, p. 266), as confirmed also by academic literature, although the loss of lives has been declining (White, Kates, & Burton, 2001; Weichselgartner & Kasperson, 2010).

Disasters are neither "acts of Gods" (among the others: Wijkman & Timberlake, 1984; Steinberg, 2000; Ambraseys & Bilham, 2011; Manyena, O'Brien, O'Keefe, & Rose, 2011) nor "instantaneous occurrences": disasters are perturbations "that reflect longstanding environmental, economic and social issues. In turn, they exacerbate those issues in the years following the event" (R. Olshansky & Chang, 2009, p. 208). Pelling explains disasters and their recurrence using the powerful image of the so-called "disaster cycle": disasters are both "discrete phenomena" (traceable in space and time) and "sequential phenomena, with each event playing a role in the shaping of subsequent risks, hazards §…]. A disaster cycle results" (Pelling, 2003, p. 13). Especially in risk-prone territories, reconstruction should contribute to risk reduction: systems should learn from past events by adapting to them and reducing the likelihood of future events (Pelling, 2003; Birkland, 2006). A "safe" condition is not static, but it is the result of continuous works for risk reduction, constantly influenced by changing cultural references and scientific innovation (Menoni, 2005; Hollnagel, Woods, & Leveson, 2006).

URBAN DISASTERS AND URBAN RESILIENCE

The history of territories, societies and cities has been influenced by the necessity of defence and security from hazards (both natural and human ones). Nature-related risks are in fact an urban issue. The mutations lived by human societies since XIX century have offered larger possibilities to overcome and control natural events: forms of mitigation, protection, prevention through technological solutions have been progressively the principal approach for defending human settlements and assets from natural hazards. Quoting a slogan for UNISDR, "risk is urbanizing" for the fast growth of urban areas in size and population density, augmenting vulnerability and exposure of people and assets, land consumption, impacts on the physical environment and climate. Cities are both cause and victim of nature-related risks in a "city-disaster nexus" (Wamsler, 2014, pp. 87-114): urbanization exacerbate disasters, and disasters impact on cities.

The notion of urban resilience is more and more present in the debate about the reduction of risks in urban environments. Godschalk interprets the nexus between urban resilience and risks stating that the "overriding goal [of urban hazard mitigation] should be to develop resilient cities" (Godschalk, 2003, p. 136). Especially the most recent definitions of resilience – focused on the capacity of a system to react to a shock by adapting to it while maintaining its key functions – represent a powerful key for investigating risk reduction approaches on the one hand, and roots and consequences of disasters on the other. Since disasters are the phenomenological result of pre-existing complex fragilities, a return to pre-existing conditions is not desirable. On the contrary, post-disaster paths should lead towards innovation and more resilient communities and environments (Manyena et al., 2011).

Moreover, risks cannot be fully predicted, nor reduced to zero: traditional paths of interventions have been mainly dedicated to contrast hazards threating physical systems, or to reinforce urban assets at risk. More recent theories and practices about resilience tends to

overcome these points of view, by matching the traditional approaches with perspectives aiming at building flexible and adaptable urban systems, able to co-exist with risks and to accept failures and uncertainties as building lock of urban path of development – shifting from "fail-safe" to "safe-to-fail" (Ahern, 2011). These new perspectives cannot be achieved only with physical and spatial transformation of cities, but by intervening also on social, normative and institutional components of the urban environment.
From this perspective, the role of urban and regional planning as technical and regulatory tools for risk prevention becomes manifest: the awareness that the city is a complex relational system consisting of interacting parts and multiple levels of organizations – where direct damages and induced effects are interconnected – leads to the necessity of non-sectorial risk reduction in urban environments. Increased safety is not derived from the sum of the safety of the individual parts but it is the result of interrelated strategies involving the entire urban system and its subsystems. The importance of planning follows consequently, given its multidisciplinary nature and role in the government of cities (Fera, 1991; Menoni, 2005; Cremonini, 2009; Davoudi, Crawford, & Mehmood, 2009). According to Esteban and colleagues, planning is a structural and non-structural long-term mitigation measure in reducing exposure and vulnerability of the built environment (Esteban et al., 2011, p. 132).

DISASTERS AND WINDOWS OF OPPORTUNITY

Nevertheless the high values at risk, the necessity of reducing risks and achieving larger resilience of territorial and urban systems raises in the debates mostly only after ruinous events (Menoni, 2005; Birkland, 2006; Guidoboni & Valensise, 2014a) and mainly to answer to general requests of "greater safety". Paradoxically enough, this "reactive" approach characterizes also places affected recurrently by ruinous events, where social and political awareness about the cyclicity of disasters, and research about disaster risk, are expected to be very high.
Instead, the process of building knowledge from unawareness and unknown emergencies to clarification and information about a known danger is filtered by cultural frameworks and collective perceptions (Alexander, 2014b). Given the losses that a disaster implies, catastrophes are expected to affect cultural references fostering transformation to reduce risks that led to the disaster (Birkland, 2006) above all if risk mitigation constitutes "a public good" (Reddy, 2000; as quoted by Menoni et al., 2011, p. 288).
On the one hand, disasters do act as accelerators, opening up "windows of opportunity" able to foster law upgrades, social mobilization and scientific debate (Birkmann et al., 2010; Alexander, 2013a); on the other hand, disasters tend to reinforce the pre-existing inertia and development path pushing "an accelerated status quo" (Pelling & Dill, 2010, p. 22; R. B. Olshansky, Hopkins, & Johnson, 2012) because crisis, like natural disasters, can lead to a compression of urgent decisions in time and space.

THIS RESEARCH

RESEARCH DESIGN AND AIMS

Supporting the necessity of fostering proactive approaches to risk reduction instead of post-disaster massive interventions, the research focuses on how cities adapt to nature-related risks, analysing how urban planning and governance contribute in promoting innovative long-term risk reduction and resilience in risk-prone urban areas. If disasters can open both windows of opportunity for innovation and windows of *dis*opportunity reinforcing pre-existing fragilities, the thesis uses post-disaster recovery processes as case studies. Ruinous events are here questioned from a double point of view: on the one hand, catastrophic events are assumed as lens for analysing which are the interrelations and clashes between ordinary and extraordinary ways of intervention for risk reduction and how post-disaster plans and policies are planned, shaped and implemented; on the other hand, the research looks at if and how disasters act as trigger events for enhancing the science-policy interface and socio-technical innovation for reducing the likelihood of future disasters in risk-prone territories.

The nature of this research is mainly exploratory-explanatory and positioned between the spheres of academic scientific research and planning policies and practices – in their design and implementation, assuming the need to foster the continuum among academic science, local governance and practices. The research interfaces between different disciplinary borders, moving from an urban planning point of view, enriched by disaster studies and political studies, grounded in Italian and international literature.
The main research questions *"How do cities reduce nature-related risks?", "Do disasters act as windows of opportunity for producing socio-technical innovation?"* are primarily addressed through a review of the literature related to mitigation and adaptation to nature-related risks and climate change, disaster studies, adaptive governance, knowledge transfer and science-policy interface (§Ch.1). The analysis of case studies allows to ground the assumptions defined in the theoretical framework (§Ch.2) and addresses both the aforementioned general questions, and the specific research questions about *"How urban planning and policies contribute in reducing nature-related risks and increase local resiliencies?", "Which are the mutual interrelations between ordinary and extraordinary ways of interventions for risk reduction, and how such plans and policies are shaped and implemented?".* The research investigates ongoing national and urban plans and projects in terms not only of contents and technology adopted, but explores also institutions and interlocutors involved, time scales involved, funding. The cases unveil also the role of available accumulated knowledge on seismic or hydrogeological risks in informing both post-emergency (short-medium term) and ordinary (medium-long term) urban policies and projects.
The research didn't follow a fixed pattern, and the methodology applied is mainly qualitative, based on case studies It was defined after a first exploratory review of the literature and documental analyses of the cases – which built the scientific and theoretical background of the research – and lately nurtured by evidence raising from fieldworks, semi-structured interviews with qualified informants, participation in dedicated technical seminars and workshops. Publications and participation to conferences during the doctoral studies allowed

the author to debate and better orient the work. The research path led finally also to a re-analysis of literature and theoretical background.

GEOGRAPHICAL FOCUS

The research is focused on the Italian territory for the scientific relevance of the case: Italy has the highest number of nature-related disasters of the Mediterranean area (Guidoboni & Valensise, 2014a, p. 7)[1]. Italy is an inherently fragile country, with a strong propensity to earthquake, landslides and floods. Around 2% of the total population of the country lives in areas with high or very high landslide hazard, and 3% in areas with high flooding hazard (Trigila, Iadanza, Bussettini, Lastoria, & Barbano, 2015); the percentage rises to 41% for seismic hazard. The severe natural hazards largely present in all the country have been amplified by the urbanization of the country: large land consumptions – shadowed in more recent times by land abandonment paths above all in rural areas – and a not incisive planning system – worsened by spread unauthorised building expansions – are just two of the root causes of the country's fragility. Natural threats involve also Italian urban systems: the ancient and recent history of several Italian cities is a history of reconstructions (Gisotti, 2012; Guidoboni & Valensise, 2014a).

The Italian case (§Ch.3) is investigated firstly as a case study itself through a descriptive and exploratory viewpoint, describing the existing nature-related risks affecting the territory and retracing the related legislation, policies and strategies addressing the field of risk reduction, analysing also the most recent programs addressing nature-related risks at the national scale. Secondly, the research addresses two case studies selected for their relevance – the cities of Genoa (§Ch.4) and L'Aquila (§Ch.5)[2] – which allow an access to grounded dimensions of the key issues of the research. Both cities are characterized by a history of shocks or stresses induced by nature-related risks, and have been recently struck by disruptive events. Genoa, the capital city of Liguria Region (North Italy) and 6th city of Italy for population size, has always been affected by very high flood risk, and experienced two dramatic floods in 2011 and 2014, with 7 victims. A large system of projects for flood risk reduction is currently in progress in the east side of the city. L'Aquila, the capital city of Abruzzo Region (Central Italy) and other 56 surrounding municipalities have been widely and severely damaged by an earthquake in 2009 that affected about 140.000 inhabitants. An enormous reconstruction process is still ongoing in the area. The different nature of risks in the cases makes them complementary in the overall aim of the research, with the purpose of keeping a larger point of view (not just hazard-related) on the topic debated.

A brief Appendix provides an overview of recent experiences in the realm of flood risk-reduction ongoing in North Europe through Nature-Based Solutions (NBS) (currently object of the Interreg "Building with Nature" European program), examples which confirm the theoretical framework at the base of this thesis and provide empirical examples and theoretical insights for questioning the domestic scenario.

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[1] Personal interests and previous experience of the author have also influenced the selection of topics and cases: she is Italian and particularly interested in environment-related questions. She took part in the definition of post-earthquake reconstruction plans in Abruzzo, and wanted to dedicate her doctoral research to further investigate the field of disaster risk reduction.

[2] The author lived in the city between 2014 and 2017.

PART I. NATURAL RISKS, HUMAN DISASTERS.

CHAPTER 1

Across the Literature

1.1 NATURE-RELATED RISKS

The expression "nature-related risk" adopted in this thesis is here used to identify risks that are triggered by natural phenomena and hazards, like earthquakes, floods, landslides, windstorms, wildfires. According to the author, this expression – instead of the widely used "natural risk" – sounds more appropriate for stressing the active role of social, economic, normative and institutional processes in exacerbating natural potentially harmful dynamics. Wamsler explains that the term "natural hazard" is "highly misleading because most hazards do also have a social or human trigger. Nevertheless, the term natural hazard is commonly accepted and justifiable to differentiate hazards with a (socio)natural trigger from other so-called man-made hazards, such as […] war, terrorism, violence, industrial hazards" (Wamsler, 2014, p. 20)[3]. The role of human activities in exacerbating natural hazards is nowadays acknowledged by research on disasters (Steinberg, 2000; Ambraseys & Bilham, 2011).

With reference to natural hazards, *Risk* (R) is widely expressed as the interactive expression of a set of components; definitions about risks vary in time and according to disciplines, and scientific literature offers a limitless collection of quantitative and qualitative values used to detail the different components of risk[4]. Risk is extensively described as related to: the probability or frequency of hazard occurrence, the possible magnitude, the potentially disruptive effect on human lives, built environments and assets. In the meantime, according to many authors risk is also inversely correlated to the preparedness or response capabilities of the affected systems, or to their "resilience" (Paul, 2011, pp. 94-96). Risk components are usually mainly reduced to *Hazard* (H), *Vulnerability* (V), *Exposure* (E) (Menoni, 2004, pp. 172-175; Wamsler, 2007, pp. 15-19; Paul, 2011, pp. 94-99; IPCC Intergovernmental Panel on Climate Change, 2014a, p. 40; Wamsler, 2014, pp. 29-30; Wisner et al., 2014, p. 45). Table 1 recalls the definitions of hazard, vulnerability, exposure, risk and resilience as adopted by the Fifth Assessment Report of the Intergovernmental Panel on Climate Change in 2014 and by the United Nations International Strategy for Disaster Reduction:

[3] The expressions "climate-related" and "non-climate related" hazards used by Wamsler (2014, pp. 20-23) suggested the expression "nature-related risks".

[4] For instance, Paul provided a broad review of the definitions of risk in his book about environmental hazards and disasters (Paul, 2011, pp. 67-117).

Hazard	IPCC: The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources
	UNISDR: A process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation. Hazards may be natural, anthropogenic or socionatural in origin.
Exposure	IPCC: The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected
	UNISDR: The situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas.
Vulnerability	IPCC: The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and lack of capacity to cope and adapt
	UNISDR: the conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.
Risk	IPCC: The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability, exposure, and hazard
	UNISDR – "Disaster Risk": The potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability and capacity.
Resilience	IPCC: The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation
	UNISDR: The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management.

Table 1. Definitions of hazard, vulnerability, exposure, risk. Sources: IPCC Intergovernmental Panel on Climate Change (2014a, pp. 39-40); General Assembly of the United Nations (2016, pp. 14,18,22,24).

Therefore, natural hazards as earthquakes, floods, windstorms and similar do not cause catastrophes *per se* but when combined with vulnerable conditions, often induced by anthropic activities – especially in urban contexts. Most available definitions of risk express this complex relation as pseudo-equations in multiplicative form, mainly as:

$$R = H * V * E$$

The multiplicative formula highlights how hazards, vulnerabilities and exposure jointly affect the overall risk: if vulnerability or hazards augment, the risk is amplified (and vice versa). Even the Italian Civil Protection embraces the same formula for defining risk in its web-

glossary[5]. The use of mathematical expressions, if useful to clarify the mutual interrelations among risk components, is misleading: assuming that the value of any component is very small, then also R decreases to almost "zero" unrealistically suggesting that a disaster will not happen (Lettieri, Masella, & Radaelli, 2009, p. 125).
Resilience (Res) – intended as the complex ability of systems to cope with a shock and "reorganize" by absorbing the disturbance and adapting to it (see Table 1 and further §Ch.1.2) – acts therefore as a "denominator" of this virtual equation, reducing R with the increase of Res:

$$R = \frac{H * V * E}{Res}$$

Following Thywissen (2006, p. 39), it is here better suggested to define the mathematical relationship between these variables as "unknown":

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

Disasters are therefore interpreted as the outcome of pre-existing conditions of risk; as defined by IPPC, disasters are "severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic, or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery" (IPCC Intergovernmental Panel on Climate Change, 2014b, p. 1763).
The field of "disaster risk reduction" (DRR) arose from the studies and practices about post-disaster interventions, and gained more consideration in the last two decades, calling attention firstly on disaster response, and then to the necessity of reducing risks and address risk in the long-term, embedding this goals in development paths (Wamsler, 2014, p. 5). The so-called "disaster cycle" is largely present in the literature about disaster studies and identifies some canonical phases of disaster management: mitigation and preparedness (mainly pre-crisis); response (during crisis and in the immediate aftermath); and recovery (post-crisis) (Berke, Kartez, & Wenger, 1993; Mileti, 1999, p. 22; Pelling, 2003, p. 25; Lettieri et al., 2009, pp. 125-126; Paul, 2011, p. 157; Wamsler, 2014, p. 52). *Mitigation* aims at minimising the degree of risk and preventing disasters, mainly through risk assessment. *Preparedness* is focused on preparing responders and common people to possible disruptive events and post-disaster activities. *Response* is based on strategies and actions to manage and control the various effects of disasters, minimising losses (through evacuation, search and rescue, sheltering, etc.). *Recovery* is the process that brings the areas "back to normal conditions". Lettieri and colleagues added three more overlapping phases: strategy (any long-term goal needs a strategy to be addressed), learning (intended as continuous improvement of processes and performances) and signalling (alerts and warning systems, communication management) (Lettieri et al., 2009, p. 126). An ideal model of the disaster cycle is sketched in Figure 1 (by Paul, 2011): the catastrophic event is recognised as a "divide", but the phases are mutually inclusive and interconnected.

[5] http://www.protezionecivile.gov.it/jcms/it/glossario.wp?letter=R

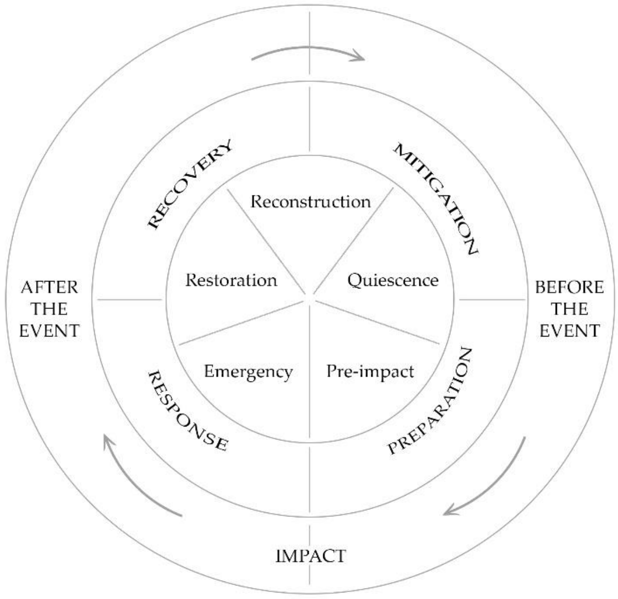

Figure 1. The disaster management cycle. Source: Alexander (2000, p. 3), as cited by Paul (2011, p. 158)

In the last two decades worldwide policy documents (e.g. the United Nations' "Yokohama Strategy and Plan of Action for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation and its Plan of Action" (1994), the "Hyogo Framework for Action 2005-2015" and the "Sendai Framework for Disaster Risk Reduction 2015-2030") and global campaigns (e.g. "Making Cities Resilient" by UNISDR[6], "100 Resilient Cities" by Rockefeller Foundation[7]) evoke the urgency to address risks by operating in multiple sectors from local social vulnerabilities to global climatic trends.

The necessity of risk prevention and reduction always recalls high attention in the aftermath of a catastrophe: it is a disaster-driven practice, called *reactive approach* because implemented as a post-event response. On the contrary, a proactive approach aims at establishing risk reduction and prevention as ordinary components of spatial transformations or urban management activities (O'Brien, O'Keefe, Rose, & Wisner, 2006, p. 70; Wamsler, 2006, pp. 5-6, 19-20; Bosher, 2014). There is still a wide tendency to interpret risk reduction as driven by mainly engineering high-tech activities, such as the implementation of stricter anti-seismic building codes for earthquake-prone areas, or the reinforcement of dykes to reduce flood risk. Moreover, hard technological and already approved approaches are generally more accepted (Jasanoff, 2013). These fundamental measures are not enough without a holistic approach addressing the drivers and root causes[8] of risks, above all when hazard cannot be reduced (such as the seismic hazard). The growing awareness about the human interferences with the climate systems and their variability, and the knowledge about the large effects of a changing climate on anthropic systems, have fostered the need of acting for "climate change adaptation" (CCA). The attention on the impact of weather-related events has recently shifted from mitigation-oriented theories towards adaptation-oriented ones, like all the theories about risk

[6] https://www.unisdr.org/we/campaign/cities

[7] http://www.100resilientcities.org/

[8] As defined by Wamsler (2014, p. 34), root causes are the interrelated structural factors, dynamics and processes within a society which have caused the present risk. Scolobig investigates root causes of risk addressing the physical, socio-economic and governance pathways, together with perceptions and values (Scolobig, 2016, p. 13).

reduction (Bulkeley, 2013, p. 143). Table 2 summarises the concepts of mitigation, risk reduction and adaptation:

Mitigation	Interventions aimed at lessening the adverse impacts of physical hazards mainly through actions that reduce hazard when possible, exposure and vulnerability.
(Disaster) Risk Reduction (DRR)	It denotes both a goal and the strategic/instrumental measures employed for anticipating future disaster risk, reducing existing exposure, hazard or vulnerability, and improving resilience.
(Climate Change) Adaptation (CCA)	The process of adjustment to actual or expected climate and its effects, by moderating or avoiding harm, and exploiting beneficial opportunities. It can assume an incremental approach (actions aim to maintain the essence and integrity of a system) or a transformative approach (actions forward deeper changes, also in the fundamental attributes of a system).

Table 2. Definitions of mitigation, risk reduction and adaptation. Elaboration of the author from IPCC Intergovernmental Panel on Climate Change (2014b).

How to face natural hazards is a topic widely discussed during the last four decades, from structural and environmental engineering studies to land use planning, at the beginning focused on reinforcing buildings and infrastructures mostly, and later more oriented to safeguard "systems" as a whole, (Wisner et al., 2014). This change is especially relevant for addressing nature-related risks in urban contexts which are complex systems with high and interrelated vulnerabilities and exposed values.

Mitigation and reduction-adaptation activities don't exclude each other – the first dedicated to prevent and control the impact of ruinous events, the latter aiming at reducing risk by anticipatory strategies, long-term decrease of hazards (when possible) or reduction of systems' vulnerability – but are complementary approaches that should be integrated into broader development strategies and policies (Smit, Burton, Klein, & Street, 1999; R. J. T. Klein et al., 2007). Adaptation and risk reduction have been developing separately for a long time, connected to two different expert communities: the scientific community working on adaptation has been dealing mainly with climate-related events, always focusing on future trends and global development; researchers occupied in risk reduction activities has been devoted also (and probably "more") to non-climatic risks and has a longer tradition focused mainly on post-disaster responses and reconstructions. This second community has shifted towards proactive-oriented approach only recently. In both groups the need of integration of risk reduction and adaption strategies is widely recognised and supported (Wamsler, 2014, pp. 45-49) [9] – and embraced by this thesis – also because links among climatic and non-climatic hazards are emergent and new approaches are claimed in order to integrate research, mindsets and communities from risk reduction and adaptation fields: "climate change is a multifaceted (from drought to flood) and multidimensional (from local to global) hazard that has short-, medium- and long-term aspects and unknown outcomes. […] Climate change can increase vulnerability to unrelated, non-climatic hazards" (O'Brien et al., 2006). The term adaptation is interpreted here with a wider scope, and not related merely to "adapt to changes". Adaptation is assumed as a development long-term practice process of coexistence with an ever-changing and risky environment towards broader resilience: tightly together with mitigation activities aiming at controlling risk, adaptation points at an overall multi-

[9] Wamsler (2014, pp. 44-55) provides a wide reconstruction of the fields of disaster risk reduction and climate change adaptation.

facets risk reduction. This approach takes into account a proactive co-life with risks, refusing reactive post-disaster tactics. In risk-prone areas and cities with recurrent stresses and shocks, resilience requires the integration of risk reduction and adaptation in ordinary governance practices.

1.2 RESILIENCE

The persuasive term "resilience" – from Latin *resilire*, "to bounce back" – is applied in many disciplines especially since the XIX century, according to different interpretations, often contradictory and unaware of the term's history; this multiplicity of the notion is plausible considering the difficulties of translation and revision of theories from natural sciences – where the term is born – to social ones (Simmie & Martin, 2010; Davoudi et al., 2012) and the partial comprehension of the interrelations between the different branches of science (Alexander, 2013b). Scientific literature provides a multitude of definitions, but basically every discipline addresses the concept in relation to *changes* and complexity. Indeed, the concept of resilience has become paramount in contexts of crisis, such as post-disaster reconstructions and more generally in the field of risk reduction and adaptation. The fragmentation of disciplines is evident also referring to "urban" resilience: each discipline tends to emphasize different aspects of the phenomena, the "cross-fertilization" among the scientific literature is evident, but often missing the interconnections in-between scientific areas (Jabareen, 2013, p. 221; Aldunce, Beilin, Howden, & Handmer, 2015, pp. 2-3; Meerow, Newell, & Stults, 2016, p. 40). In Figure 2, a literature map draws a network of primary and secondary theoretical relations between the main topics and fields of research about the concept of "resilience", progressively leading to the notion of "urban resilience". The map clarifies overlaps and mutual dependencies among disciplines in a highly scattered literature, inspired by Alexander's research on meaning and uses of the term "resilience" in the field of disaster risk reduction (Alexander, 2013b).
Two recent complex definitions of resilience and urban resilience are offered by Vale (2014) and Meerow, Newell and Stults (2016), here provided: "Resilience, in turn, is both a concept and a practice, increasingly deployed to link concerns about community development and disaster preparation to large global challenges such as climate change that will have significant consequences not just for the "globe" but for specific underserved communities in specific vulnerable places. Resilience is, simultaneously, a theory about how systems can behave across scales, a practice or proactive approach to planning systems that applies across social spaces, and an analytical tool that enables researchers to examine how and why some systems are able to respond to disruption" (Vale, 2014, p. 191).
"Urban resilience refers to the ability of an urban system – and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales – to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity" (Meerow et al., 2016, p. 39).

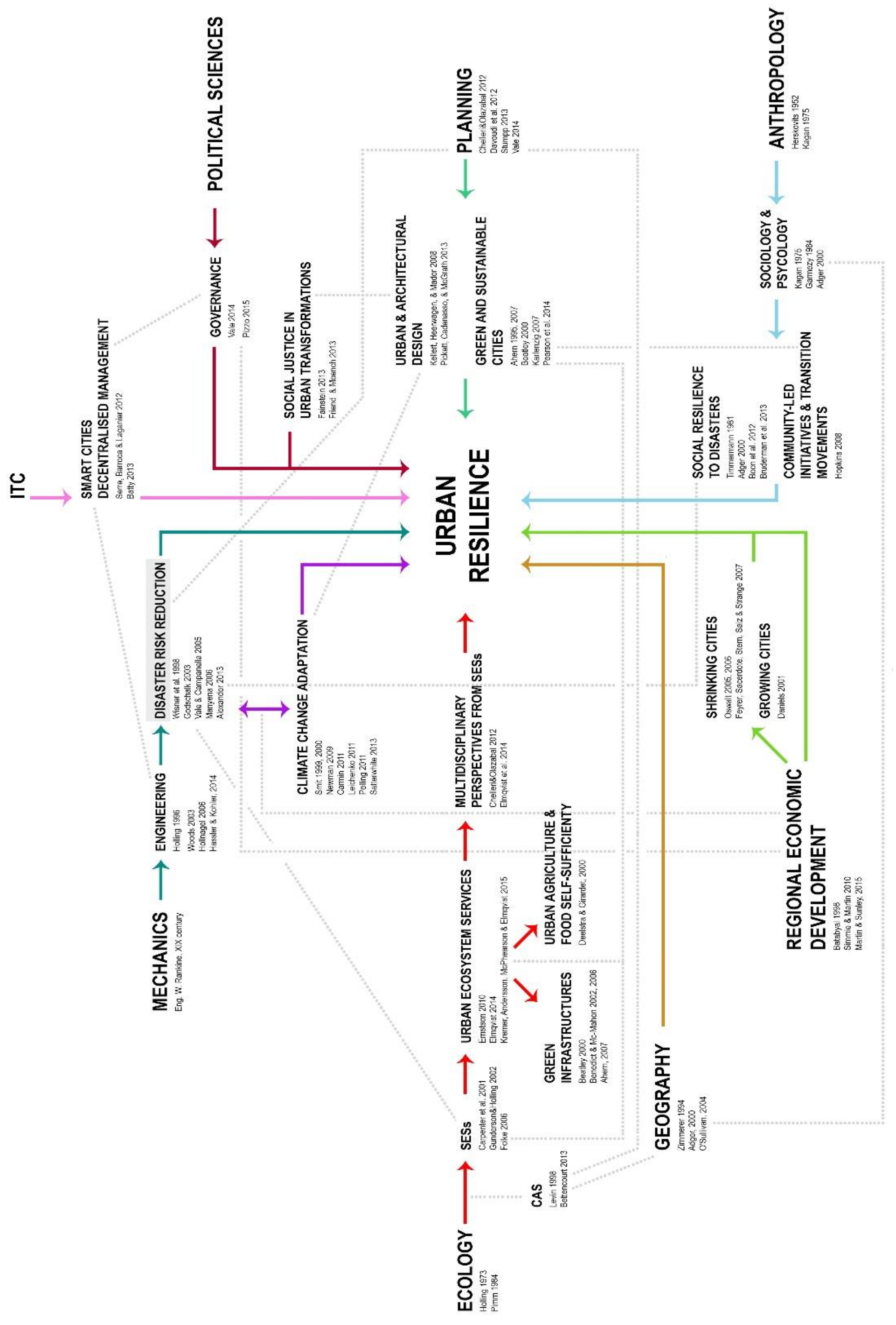

Figure 2. Literature map and conceptual network of research about urban resilience. Arrows indicate the principal connections; grey lines draft the secondary relations. Key references for each topic are listed. Elaboration of the author.

The concept of resilience is born in engineering and ecological studies and progressively developed in manifold fields, being applied to a vast range of disciplines, as traced in Figure 2. Holling's definition of resilience, generally accepted as the fundamental basis of research on this topic, was developed in ecological studies: resilience is the ability of systems to absorb changes and still persist, maintaining their internal relationships even fluctuating between different domains of attraction, while stability is the ability to return to an equilibrium condition after a shock. Holling asserted that resilience perspectives need diversity and "keeping options opens" to adapt to future unexpected events, focusing his research on multi-stable states, variability and heterogeneity, and not on constancy (Holling, 1973, p. 17). An interpretation of resilience as the "return time after disturbance" and therefore as a "bounce-back" ability gained large attention, and has deeply shaped the contemporary approach to environmental management: it was focused on a quick return to a previous equilibrium state (Pimm, 1984, p. 322) and has been defined as "engineering resilience" (Holling, 1996, pp. 32-33). Nevertheless, several disciplines and fields of research – such as ecology, mechanics and engineering, information technology for communication, political sciences, planning, anthropology and psychology, economics, geography – embraced the notion shifting its interpretation progressively from the "engineering" vision of resilience and recovery models (the most familiar and traditional one) towards the "ecological definition" of resilience, which became the foundation for adaptive ecosystem management processes, framing a heuristic and interdisciplinary model of development that assumes non-linearity, multi-stable states and uncertainties as inevitable (Clark & Munn, 1986; Stephen R. Carpenter & Gunderson, 2001; Gunderson & Holling, 2002; Folke, 2006).

Gradually, many theories have embraced Holling's positions about "multiple equilibria states" and dynamic behaviour of complex ecosystems (Holling, 1986). Resilience has been defined as a property of Complex Adaptive Systems (CAS): according to Levin, the key to resilience in any CAS – such as ecosystems and cities – is in the maintenance of heterogeneity, the essential element that enables adaptation (Levin et al., 1998; Bettencourt, 2013). Starting from these principles, ecology research on resilience has moved afterwards to wider interpretations, including studies on Social-Ecological Systems (SESs). As stated by many scholars[10], SESs are living systems, result of the interplay between human and natural components; they evolve continuously not tending to "equilibria" but following different dynamics and trajectories of interaction, adaptation and transformation; the shifts between different conditions can be gradual, or sudden and unexpected, and mainly originated by human actions. As Folke summarized in 2006, "the resilience approach is concerned with how to persist through continuous development in the face of change and how to innovate and transform into new more desirable[11] configurations" (Folke, 2006, p. 260). According to these interpretations[12], disturbances, crises and changes are not just dangers to avoid, but part of the natural evolution and, further, potential constructive opportunities for innovation (recombination of structures and processes, emergences of new perspectives). This vision refuses the idea of hierarchical status of equilibrium to come back to, and broadens the engineering and ecological definitions of resilience incorporating the dynamic interplay between phases – from "persistence" to "transformability" – across multiple scales and timeframes (Folke et al., 2010). Davoudi et al. (2012, p. 302) speak openly of "evolutionary resilience" stressing the notion towards a more "progressive" focus: "This view of resilience reflects a paradigm shift in how scientists think about the world. Rather than seeing the world as orderly, mechanical and reasonably predictable, they see it as chaotic, complex, uncertain, and unpredictable".

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[10] Among many others: (Steve R. Carpenter, Walker, Anderies, & Abel, 2001; Gunderson & Holling, 2002; Folke, 2006; Walker & Salt, 2006; Folke et al., 2010).

[11] The notion of "what is desirable" needs to be clarified and changes for every field of application. From an ecological point of view, it can be referred to states with a lesser capacity to provide ecosystem services, for instance.

[12] They mainly refer to the "panarchy model" by Gunderson and Holling (2002).

In an urban era "where cities have become a central nexus of the relationship between people and nature"(Elmqvist, 2014), the conceptualization of urban sustainability should encompass resilience in urban transformations (Elmqvist, Barnett, & Wilkinson, 2014). Indeed, looking at cities as CAS, multidisciplinary perspectives originated from SESs are rising to address the challenges of contemporary urban environments through the "change-oriented" lens of resilience, looking at the interplay of multiple attractors in shaping urban transformation at different scales (in terms of persistence, change, adaptability, transformability) (Chelleri & Olazabal, 2012; Davoudi et al., 2012; Chelleri, Waters, Olazabal, & Minucci, 2015) and, conversely, the metaphor of a resilient city – indicating both a process and a product of design and politics (Vale, 2014, p. 200) – portrays "a city capable of withstanding, absorbing and recovering from sudden events and chronic stresses" (Galderisi, 2018, p. 11). The notion of resilience is undoubtably interrelated to the notion of reaction to a disturbance – because of its own etymology. Consequently, resilience has progressively emerged in the debate about disasters and risk reduction, and the "idea of resilience suggests a proactive stance towards risk" (Wamsler, 2007, p. 130). Especially the most recent interpretations that do not look at resilience as a return to a "pre-existing equilibrium" but focus on the capacity to maintain key functions and to the adaptive and transformative potential of it (Chelleri et al., 2015), are particularly suitable for investigating post-disaster contexts, where the return to previous conditions is not achievable and often not desirable. As O'Brien and colleagues argue, "risk reduction is the shared objective, but it is the promotion of resilience that offers the opportunity for more holistic and proactive responses" (O'Brien et al., 2006, p. 70). Focusing on the mutual influences between disaster risk reduction and resilience, Godschalk interprets the nexus between urban resilience, risk and vulnerability stating that "urban hazard mitigation is a particular branch of hazard mitigation practice, and [...] its overriding goal should be to develop resilient cities" (Godschalk, 2003, p. 136). Accepted that risks cannot be predicted completely nor reduced to zero, more recent theories and practices about resilience tends to overcome traditional views dedicated mainly to contrast hazards threating physical systems, and are oriented to build flexible urban systems, including also the socio-institutional components (as in IPPC definition, see §Ch.1.1, Table 1). Nevertheless the efforts and the wide theoretical debate, the notion of resilient city is still often used according to a "bouncing-back" perspective (Galderisi, 2018, p. 17).

Without denying the fundamental reduction of hazards or vulnerabilities through physical material interventions, disaster risk reduction and post-disaster recovery processes need to move from outcome-oriented conceptualization of resilience to more process-oriented ones, above all if we interpret disasters as catalysts for transformation. This means promoting wider visions of recovery, building local knowledge and awareness, reframing planning focusing on a complex meaning of resilience. In Manyena's words, resilience is the ability of "bouncing forward" and "move on" following disasters (Manyena, 2006; Manyena et al., 2011)., Using examples about flood risk, Liao sharply portrays how the "resilience thinking" shows possible paradigm shifts in disaster risk reduction: thus, urban resilience to floods can be defined by "floodability and reorganization, not by flood resistance", restructuring the goal of "safety against floods" – typical of engineering resilience an traditional approach of intervention – by redirecting the flood management agenda towards the concepts of "living with water" and "safety at floods": cities learn to live with periodic floods and become resilient to extreme ones (Liao, 2012). Such paradigm shift is peculiarly evident in the growing experimentation of "nature-based solutions" (NBS) for reducing nature-related risks (§Appendix): NBS are living, complex engineering solutions which exploit or mimic environmental dynamics for reducing risks or adapt to extreme events. NBS are defined as innovative potential opportunities for disaster reduction while offering shorter-term benefits compared to the longer-term ones generally generated by risk prevention activities (European Union, 2015, p. 33).

1.3 URBAN PLANNING AND GOVERNANCE FOR RESILIENCE AND RISK REDUCTION

Risk is "becoming increasingly urbanized" as shown by major urban disasters worldwide, also due to changing climate conditions (Bulkeley, 2013, pp. 7-9; Wamsler, 2014, p. 3). Assuming risk as correlated to the vulnerability, exposure and resilience of a system, the urban impact of a natural hazard (such as the seismic hazard) is strongly dependent also on the characteristics of the built environment and by modification of ecosystems in urban contexts. Artificial surfaces that cannot absorb water or reduce heat, poor house constructions or inadequate maintenance, weak social networks, no risk-aware planning, illegal buildings in hazard-prone areas, weak alert management systems: these are examples of risk factors in contemporary cities, cities which are both (direct or indirect) generators of hazards, both vulnerable systems highly exposed to them. Disasters are not "natural" especially in urban contexts: on the contrary, they are the result of a physical, social, institutional and economic construct.

Defining urban planning is challenging, as openly stated in the encyclopaedia of urban studies: "Urban planning has become a difficult discipline to define precisely because of its eclecticism, which itself is a result of different levels and conceptions of urban planning that have developed over the last half-century" (Hutchison, 2010, p. 903). Urban planning aims at understanding and managing urban systems and their transformation, bridging knowledge and action: therefore, it includes manifold activities related to spatiality and temporality of cities, crossing multiple policy sectors, from land use planning to urban design and management of spaces. Physical, social, economic institutional, ideological and political factors influence planning, which is recognised as an interactive and non-linear process ranging "from a design-based to a social science-based activity" (Davoudi, 2012, p. 439). Research on risk reduction has recognised the role of both regional and urban governance and planning in influencing the levels of risks, reducing or exacerbating natural hazards through infrastructural and technological measures, urban design technics, building codes, land-use plans etc. Planners, in fact, have been traditionally involved in mitigation activities – as discouraging development in hazardous areas – and are as well involved in post-disaster recovery planning (Fera, 1991; Menoni, 2005; Cremonini & Galderisi, 2007; R. Olshansky & Chang, 2009; Esteban et al., 2011). Assuming risk as correlated to vulnerability and exposure, the urban impact of a hazard is strongly dependent on the characteristic of the built environment, therefore dependant on urban planning practices and governance processes acting as counteracting or reinforcing forces.
Resilience arose as a topic for urban planning at the end of the 2000s, mainly from the aforementioned debates about environmental issues and the mitigation of natural risks (Olazabal, Chelleri, Waters, & Kunath, 2012; Pizzo, 2015) and involving broader areas of the

discipline[13]. Davoudi questions if resilience represents a useful concept for planning theory and practice or if it is just a buzzword, underlining that the investigation for spatial equilibrium could be found in the modernist visions of cities, and recalling that the translation of resilience thinking in planning was deeply influenced by the interpretation of resilience as a bounce-back ability, reason for which the resilience-building literature is dominated by post-disaster emergency planning (Davoudi et al., 2012). In planning, the interpretation of resilience as ability to deal with dynamic development paths is a recent accomplishment, helped also by social-ecological sciences (Wilkinson, 2012). The transformation of a system respect to a pre-shock state shouldn't be recognised as a failure in absolute terms, but as a possibility: in these terms, Davoudi proposed the aforementioned definition of "evolutionary resilience" refusing both a return to "normality", and the idea of changes inducted only by external disturbances following cause-effect trajectories. The author refers to the "panarchy model" (Gunderson & Holling, 2002) quoted also in note 12, that broadens engineering and ecological description of resilience incorporating the dynamic interplays across multiple spatial and temporal scales (Davoudi et al., 2012). On the one hand, the introduction of resilience and complexity issues inside urban planning open to a paradigm shift in theories and practices: the traditional tools of planning are static, not drawn to deal with complexity, dynamic processes, failures. On the other hand, a not adequate relationship between academic debate on planning theories and resilience-building practices is plain: policies and practises often "struggle to reconcile the broad applicability of the concept with place-specific social processes" (O'Hare & White, 2013, p. 278).

DRR and CCA refer to areas of knowledge that were developed independently as explained above, despite the shared aims of reducing occurrence and impacts of disasters, and need a better interface in the realm of urban planning and urban risk governance, as well specific "capabilities" of individuals, communities and institutions implementing the necessary measures for increasing disaster resilience (Wamsler, 2014, pp. 8, 27). Also the United Nations' 2030 Agenda for Sustainable Development underlines the goals of "adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement […] holistic disaster risk management at all levels" (Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable. General Assembly of the United Nations, 2015).

These assumptions find a powerful summary in Wamsler's taxonomy of strategies for mainstreaming risk reduction and adaptation – which maximize their potential when combined: strategies involving *programs* (fostering risk reduction and adaptation through specific dedicated programs and/or through the integration in ordinary urban programs), strategies involving *organizational/institutional functioning* (promoting modification of legislation, policies, institution management, tools to implementing and institutionalize risk reduction and adaptation as "standard" practices); strategies involving *interinstitutional collaborations* (fostering cooperation among actors for promoting a more collaborative planning and management, and improving education and capacity development for risk governance) (Wamsler, 2014, pp. 56-63). Urban planning involves both the regulatory/legislative frameworks for physical transformations (of land, housing,

[13] Although the recent appearance in this debate, building resilience is not a new topic for planning, even if addressed with partial measures and using another phraseology (Albers & Deppisch, 2012); planning already started dealing with uncertainties, for instance through strategic planning: thus, resilience emerges as "a new lens for looking at what is already known" (Pizzo, 2015, p. 139). Resilience planning is often already practised by communities, even though not so labelled (Manyena et al., 2011).

infrastructures, services) and the social, financial, institutional systems through which those frameworks are designed, implemented, transformed, maintained. Urban governance – intended as the system of governing urban transformations exercised by a multitude of context-dependent interacting stakeholders, agendas and decision-making processes – represents a fundamental side of risk reduction and adaption strategies for incorporating the "duty to implement" such strategies, influencing (and being mutually influenced by) urban planning (Wamsler, 2014, pp. 63-64). Adaptation to risks is indeed shaped "by the interaction between vulnerability, adaptive capacity and adaptation deficits" intended the latter as the lack of basic infrastructures and services for adapting to risks on the one hand, and the lack of local capacity – of individuals and institutions – to not only gather knowledge and planning and design strategies, but also to implement and maintaining adaptation measures (Bulkeley, 2013, pp. 146, 159)Taylor and Harman highlighted the challenges of governing urban systems for dealing with climate-related risks by embracing adaptive approaches. These challenges can be extended to nature-related risks: the lack of interest in going beyond compulsory standards and prescriptions for fear of lost development opportunity or profitability; the subsequent predominance of reactive approaches which foster safeguard and improvements in the planning system only after major events; the delays in translating risk policies into operational design standards and practices; the tendency to outsource long-term environmental risks to the broader planning system and the consequent rhetorical, institutional and material responsibility gap between actors (Taylor & Harman, 2015, pp. 14-15).

1.4 THE SCIENCE-POLICY INTERFACE

There is a recognised gap between scientists – knowledge producers – and policy decision makers (and practitioners) – knowledge users – in the policies, strategies and practices for disaster risk reduction (White et al., 2001; Weichselgartner & Kasperson, 2010). Formal reporting on the 2005-2015 UN Hyogo Framework for Action identified Priority 4 *"Reduce the underlying risk factors*" and Priority 3 *"Use knowledge, innovation and education to build a culture of safety and resilience at all levels"* as the most difficult to implement (UNISDR United Nations International Strategy for Disaster Reduction, 2013). In 2015 UN Sendai Framework for Disaster Risk Reduction 2015-2030 (UNISDR United Nations International Strategy for Disaster Reduction, 2015) replaced the Hyogo Framework, and formalized the role of both policies and practices, and of science and technology, in moving beyond hazard-dominated research and supporting evidence-based policy making (Pearson & Pelling, 2015). Pearson and Pelling interpret the poor progress in these fields as symptomatic of necessary larger efforts to tackle both underlying gaps in our understanding, both root causes of risks: "Reconnecting civil society and science with policymaking is the first task in implementing the Sendai Framework for Disaster Risk Reduction and in establishing common agendas at the national and local levels […]. This would be a legacy of leadership that the Sendai process could be proud of" (Pearson & Pelling, 2015, p. 11).

The science-policy interface is indeed a "complex two-way process, rather than a simply a transfer of knowledge from science to policy" (Sutherland et al., 2006, as quoted by Spray, Ball, & Rouillard, 2009, p. 165). Change, innovation and knowledge transfer from science and research into practices are openly discussed in several disciplines, from medical research to political studies. Lavis and colleagues in 2003 built a pivotal framework for a knowledge-transfer strategy around five core elements: i. the message, ii. the target audience, ii. the messenger, iv. the knowledge-transfer processes and supporting communications infrastructure, and v. the desired effects of the transfer (Lavis, Robertson, Woodside, McLeod, & Abelson, 2003, p. 222). The same core issues can be recognised in a framework developed by When and Motavo (Figure 3) that widens the interrelated dynamics: the knowledge "recipient" and the knowledge "provider" are the target audience and the messenger; the knowledge-transfer processes is two-fold: it depends both on the internal process influencing the willingness to the transfer of each knowledge provider and recipient, and the actual exchange among the two, which implies the expected outcomes of all the transfer (Wehn & Montalvo, 2018). Also according to Landry and colleagues, the use of research is a cumulative process (in six stages: i. transmission; ii. cognition; iii. reference; iv. adoption; v. influence; vi. application) where research findings are more and more rarely used moving further in the process (Landry et al., 2001, as quoted by Mitton, Adair, McKenzie, Patten, & Perry, 2007, p. 741).

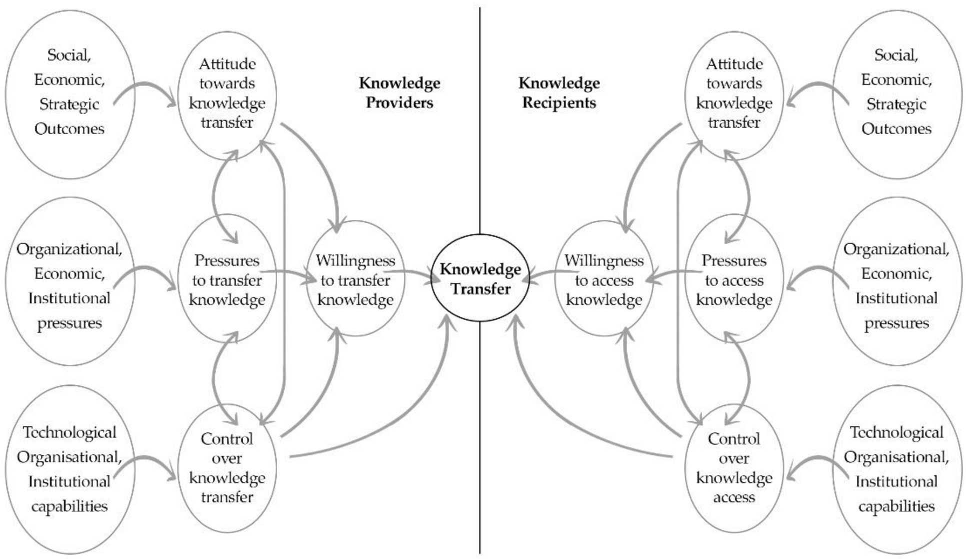

Figure 3. Behavioural (a)symmetries for knowledge transfer. Adaptation of the author from Wehn and Montalvo (2018, p. 60)

Analysing how policymakers – the knowledge "recipients" – use research evidence, the works guided by Grimshaw and Mitton highlight some structural elements influencing the science-policy interface. Grimshaw and colleagues recognise the "research that matched the beliefs, values, interests, or political goals and strategies of selected officials, social interest groups" involved in the transfer is a factor able to increase policymakers' use of research evidence (Lavis et al, 2005, as quoted by Grimshaw, Eccles, Lavis, Hill, & Squires, 2012, p. 13). Also Mitton and colleagues sustain that evidence and facts do not represent the pillars of policy-making: "Evidence seldom has a rationally linear impact, given the complexity of the decision-making context" (Whiteford, 2001, as quoted by Mitton et al., 2007, p. 739). Barriers about the effective translation and use of knowledge from science to practice highlight a complex interdependent network. For instance, in their review Grimshaw and colleagues identify : knowledge management resources (e.g. how to manage the volumes of research evidence produced); structural and organizational barriers (e.g. financial disincentives, lack of facilities or equipment); peer group barriers (e.g. local standards not in line with desired practice); professional barriers (e.g. attitudes and skills) and interaction barriers (e.g. communication issues) (Grimshaw et al., 2012, p. 5). The relation between knowledge and policies seems controversial also in environmental policies, a field where the necessity of evidence-informed guidelines – built on a solid understanding of physical, natural and social systems and their interdependencies – should sound obvious (Holmes & Clark, 2008). This paradox emerges also in disaster studies: on the one hand, knowledge base and research efforts about nature-related risks and disasters grow constantly, both at local and global scale; on the other hand, frequency and impact of disasters is increasing (§Introduction). In White and colleagues' words, it's the oxymoron of "knowing better and losing even more" instead of leading towards better results (White et al., 2001; Weichselgartner & Kasperson, 2010): high-quality knowledge is not lacking, and improvements in disaster first response is documented, especially in developed country. Nevertheless, important limits characterize the effective application of available knowledge for addressing root causes of risks and improving adaptive capacity, activities that put in question the status-quo of cities and communities: lack of institutional capabilities, lack of political will and conflicting interests (and lack of financial resources as well) slow down transformative paths worldwide (White et al., 2001, pp. 89-90). If many barriers can be ascribed to the lack of institutional and political skills and motivations – requiring an organization change ("as long as disaster losses can be absorbed by an economically rich society, the motivation for action to counteract losses due largely to growing wealth is not likely to be strong enough": White et al., 2001, p. 90) – equally weak engagement of knowledge producers in overcoming boundaries among disciplines (and responsibilities) and meeting decision makers' and practitioners' needs and inputs, impede both a more effective transmission of existing knowledge, and an innovative interdisciplinary research (Weichselgartner & Kasperson, 2010, p. 274). To achieve the latter, it's necessary also a cultural shift, embracing holistic interactive perspectives which questions the current approach to knowledge production, addressing the frequent fragmentation and heterogeneity of data and competences, the lack of monitoring on results, the tendency to single-discipline sector-based research (Weichselgartner & Kasperson, 2010, p. 276; Galderisi & Limongi, 2017, pp. 66-67): "a shift from a single element/sector approach to the different threatening phenomena towards a holistic approach to cities development, capable to link different knowledge domains as well as to emphasize linkages and interactions between natural and social systems as a key step to identify priority areas and interventions and support cross-sectoral strategies aimed at enhancing urban resilience" (Galderisi & Limongi, 2017, p. 42).

For analysing how policies change by the utilization of research progresses, Johnson, Tunstall and Penning-Rowsel defined a theoretical integrated framework on "incremental and catalytic policy changes" related to flood risk reduction, drawing from a range of theoretical positions, in particular from: studies on *"policy advocacy coalitions*" by Sabatier and Jenkins-Smith (1993), the *"policy streams"* approach by Kingdon (1995), and the *"punctuated equilibrium approach"* by Baumgartner and Jones (1993) (Johnson, Tunstall, & Penning-Rowsell, 2005, pp. 562-564). The framework moves from the assumption that the policy process is relatively stable but "disturbed" by moments of rapid change: if none or minor disturbing events occur, the framework follows incremental changes; in occasion of national scale events, catalytic changes occur in policymaking. The differences between the two kinds are: the rate of policy change; the extent to which new participants are involved in an issue; how new actors are mobilized by policy entrepreneurs. A "policy windows of opportunity" emerge indeed when:

a problem is recognized as a public matter in need of attention; policy entrepreneurs can offer potential solutions to the problem, at a time when there is political and institutional receptivity to such a solution. Policy windows do not stay open for long, and can result in any policy change depending on the ability of the policy entrepreneurs to get their issue onto, and keep it on, the policy agenda. As suggested by R. Olshansky and Chang (2009, p. 200) disasters open rare but brief windows of opportunity for performing long-lasting change due to increased awareness and the availability of special funds. As introduced above, both behavioural (values and beliefs of actors) and contextual (norms, events) factors influence the definition of a problem, but they do not determine change *per se*. Rather: institutions, organizations, technology, socioeconomic conditions and politics are the important contextual factors through which ideas float in policies (Johnson et al., 2005, p. 565). Catalytic change emerges when events alter the networks between knowledge providers and recipients because they provide the opportunity for increasing: i. the number of issues negotiated and ii. the range of actors involved, each pushing for their own ideas to gain ground. Therefore, the underlying values, beliefs and norms of society – alongside with the barriers influencing knowledge translation – existing at the time of a ruinous event, influence post-disaster discourse and action. Disaster studies suggest that the impact of disasters on policy change appears to be dependent on a combination of contextual, behavioural and environmental drivers such as the magnitude of the disaster; the availability of technology, knowledge and information at the time of the event; the socio-economic, political and governance structures in place; the dominant actors' attitudes and interests. The belief systems, values, policy positions, agendas already under consideration at the time of a crisis, gain prominence after it, and impact on the nature of the policy response (Johnson et al., 2005; Birkland, 2006; Smith, Porter, & Upham, 2017). Birkland especially interprets disasters as "focusing events" defining a "potential focusing event as an event that is sudden, relatively rare, can be reasonably defined as harmful […] and that is known to policymakers and the public virtually simultaneously" (Birkland, 1997, as quoted by Birkland, 2006, p.2). From his perspective, focusing event foster "changes" only in the rare case of high social attention is supported by peculiar accumulated knowledge, but they rather reinvigorate the focus on pre-existing ideas and approaches (Birkland, 2006, pp. 173-183).

The literature exploring nature-related risks and urban resilience, and how these aspects are addressed by urban planning and governance in contemporary cities, is at the base of the theoretical framework described in §Ch. 2, and used to investigate the cases explored in §Ch.3, 4, 5.

CHAPTER 2

Theoretical framework and Methodology

2.1 DEFINING A THEORETICAL FRAMEWORK

The research is positioned between the spheres of academic scientific research and concrete policies and practices – in their design and implementation, assuming the need to foster the continuum among academic science, local governance and practices. On the one hand, disasters are not "instantaneous occurrences, but rather they […] reflect longstanding environmental, economic and social issues. In turn, they exacerbate those issues in the years following the event" (R. Olshansky & Chang, 2009, p. 208); on the other hands, risk is becoming increasingly urbanized (Wamsler, 2014, p. 3). To analyse how cities adapt to nature-related risks, the research interprets *ruinous events* and the extra-ordinary policies and programs which follow as lens to question the role of *ordinary* urban planning and governance in reducing nature-related risks and increase local resiliencies in risk-prone areas.

Building resilience through the disaster cycle

The "disaster cycle" (§Ch.1.1) is here reconsidered to test the role of urban planning and policies in "times of peace" for mitigating and adapting to nature-related risks. The research moves from Mark Pelling's introduction to his pivotal book about the "vulnerability of cities" (Pelling, 2003): shocks are here interpreted both as "discrete" phenomena (which have a more or less observable beginning and end), and as "sequential" phenomena, while each event contributes in shaping the future risks, the future resilience, the future ruinous events – especially when involving known risk-prone areas. Nevertheless the event (the crisis) is recognised as "the divide", canonically separating time and places in "before it" and "after", the phases of the disaster cycle – mitigation, preparedness, response and recovery – are mutually inclusive and entangled, they overlap or can be experienced differently in diverse areas simultaneously, especially in complex urban systems (Berke et al., 1993; Pelling, 2003; Lettieri et al., 2009). The disaster cycle is very context-dependent, but an ideal model, based on the literature, is outlined in Figure 4, emphasizing the overlapping among phases:

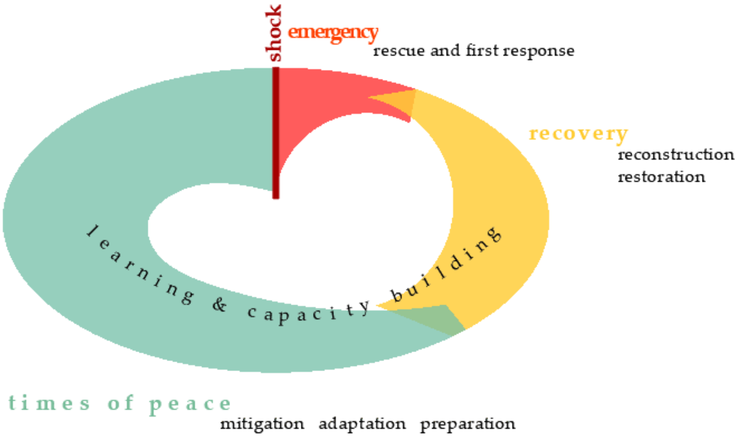

Figure 4. The disaster cycle as interpreted by the author.

In the disaster cycle, pre-emergency preparedness strategies (risk analysis, preventive and mitigating actions, risk communication and information systems, formulation of emergency responses) are interrupted by a warning (if the event is predictable) or directly by a shocking event. Immediately after the shock, an emergency phase opens up, led by front line respondents and dedicated to rescue activities, for saving lives, minimising damage and provide emergency shelters. The emergency is followed by the restoration of basic services and infrastructures, and the physical and socio-economic large-scale reconstruction.

In 1993 Berke and colleagues stated how "the recovery phase is the least investigated and most poorly understood" among the phases of a disaster (Berke et al., 1993, p. 94); recent studies confirm this statement, in spite of the numerous catastrophic events occurred across the world since 2000 (Lettieri et al., 2009; R. B. Olshansky et al., 2012; Mannakkara & Wilkinson, 2014)[14]. Inspired by this gap, the cases analysed in this thesis are focused on post-disaster recovery for investigating the entire cycle, assuming that post-disaster recovery is a process bridging all the phases from risk mitigation to long-term reconstruction strategies (Berke et al., 1993; Chang, Wilkinson, Potangaroa, & Seville, 2010; Cheng, Ganapati, & Ganapati, 2015). In areas struck recurrently by ruinous events, a reconstruction bridges the return to a new "normality" (another time of peace) and – assuming the determination in improving learning and capabilities[15] – to a new phase of adaptation and preparedness for reducing future risks and the disruptive effect of future events. Moving further, the work of Thomas Birkland about "post-disaster policies" (Birkland, 2006) offers a more specific theoretical reference for this research (§Ch.1.4). Some ruinous events happen rarely and unexpectedly, but most nature-related disasters, on the contrary, happen in well known risk-prone areas, that experience recurrent crisis or that lived well-documented disasters in the past. Birkland's claim, assumed in this thesis, is that forms of evaluation and consequent reduction of existing risks should be constantly put in place in risk-prone territories, and that ruinous events should

[14] Lettieri and colleagues (2009) added "learning" to the neglected phases (§Ch.1.1). Yi and Yang underlined how "post-disaster reconstruction as research topic has received increasing attention during the last decade" (Yi & Yang, 2014, p. 24).

[15] According to Birkland, participants in policymaking are engaged in a learning process if they use the available knowledge to test their beliefs and/or refining them by acquiring more information about the problem, the possible solutions, and the arguments needed to advance their preferred options (Birkland, 2006, pp. 8-9).

trigger forms of *risk-reduction policy change* – and not only *agenda changes*) – in the affected areas.

The interpretation of the disaster cycle as a continuous process implies a proactive, holistic approach to risk reduction assuming that disaster-risk-zero in not achievable (Lettieri et al., 2009, p. 125), and because all risk components and their interactions are co-influenced by natural and anthropogenic processes[16]. Disaster reduction therefore should contribute to a "sustainable" development as well: "It is at the nexus between sustainable development and policy that the aims of the disaster, development and climate change communities intersect. Risk reduction is the shared objective, but it is the promotion of resilience that offers the opportunity for more holistic and proactive responses" (O'Brien et al., 2006, p. 70). Indeed, as described in §Ch.1.2, resilience – in its most recent interpretations – synthesises both after-crisis activities and responses (grounded on the capabilities needed to cope with a wide variety of risks) and before-crisis activities (grounded on long-term risk reduction) (Lettieri et al., 2009, p. 125; Davoudi et al., 2012). Resilience concept has helped the "representation of the causes of disasters as complex interactions" between society, physical and built environment, and consequently to bridge the "gap between pre-disaster actions and post-disaster interventions, and between structural […] and non-structural […] mitigation" (Bornstein, Lizarralde, Gould, & Davidson, 2013, pp. 46-47). Structural measures consist mostly in engineering solutions designed to reduce the physical hazards (e.g. landslide consolidation, anti-seismic strengthening of buildings); non-structural measures act through "softer" interventions as community-oriented or managerial transformation (e.g. the implementation of alert systems and risk awareness programs). Structural and non-structural measures are merged – even if with different weights and roles – in land use spatial planning, in the design of green infrastructures or nature-based interventions for risk-reduction (Menoni, 2004; Esteban et al., 2011; European Union, 2015; Kabisch et al., 2016. See also §Appendix).

In the light of these interpretations of the disaster cycle and of the notions of resilience, Figure 5 proposes the continuous process linking risks, recovery phases and the reinforcement of local resilience, bridging the gap between pre-disaster actions and post-disaster interventions. A datum risk (R) influence the potentially ruinous impact of a nature-related event (E) and the following emergency phase. The subsequent reconstruction (Rec) should take the form of a new phase of adaptation and learning, for maximizing the social and economic efforts of a reconstruction and for increasing the resiliencies of the system (§Ch.1.1, 1.2) with the purpose to achieve a hopefully smaller level of risk in a new time of peace (R'). Consequently, the impact of a future event (E') should be reduced as well as the scale of the necessary reconstruction afterwards (Rec'). The shared goal of the interventions should be to learn from the previous ruinous events and accumulated experience to augment the resilience of the system (and capabilities) again and keep growing, in order to achieve R" < R', and so forth.

[16] E.g. climate change can exacerbate some hazards; socioeconomic patterns and local governance can influence vulnerability and exposure) (IPCC Intergovernmental Panel on Climate Change, 2014a, p. 1046)

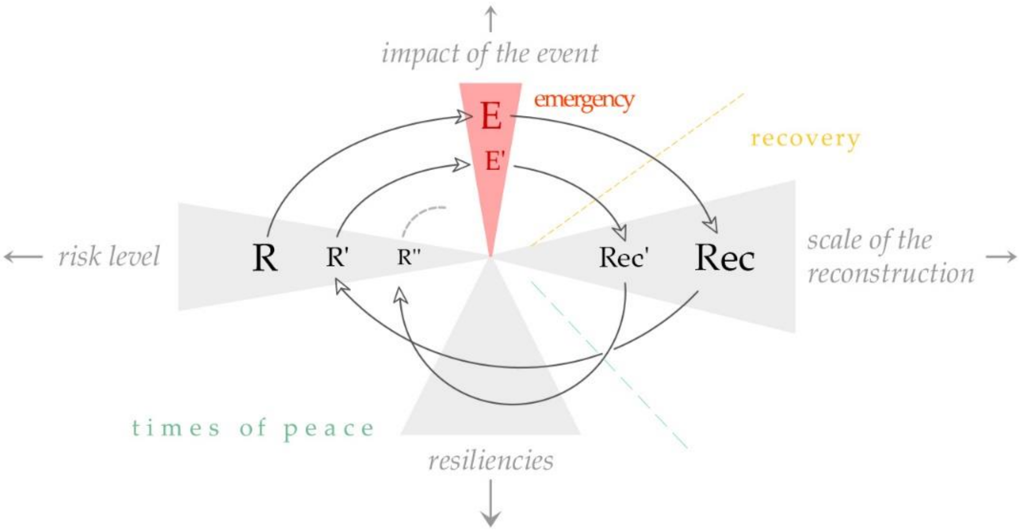

Figure 5. Risk (R), Shock Event (E) and Recovery (Rec) as idealised by the author according to the disaster cycle in conditions of recurrent risks.

Windows of opportunity and time compression

The shared goal of post-disaster interventions should be to reduce future risks while recovering from the event. To reach this specific goal, a change is needed in the governance of risk reduction and adaptation to force the disaster cycle towards more sustainable patterns, for interpreting a reconstruction also as a process of innovation and knowledge transfer from science and research into practices. The core assumptions from relevant literature about science-policy interface (§Ch.1.4) have been used to build a more robust theoretical background, especially the mutual dynamics among "knowledge providers and recipients" as outlined by Wehn & Montalvo (Figure 3), and Birkland's assumption about disaster-related policy change, summarised in Figure 6:

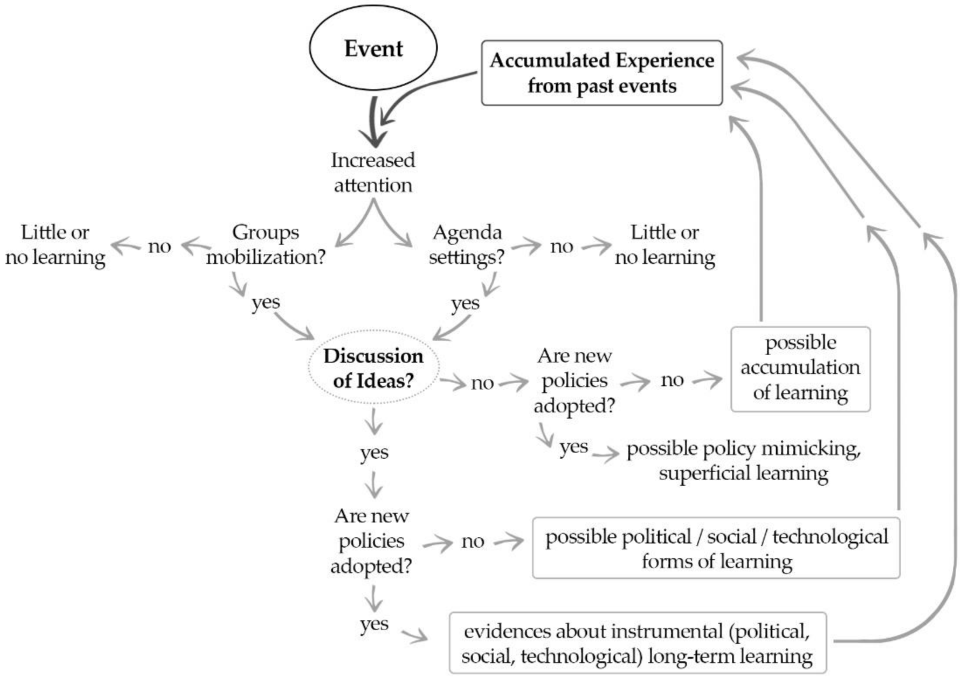

Figure 6. Event-related policy learning. Adaptation of the author from Birkland's model (2006, p. 18)

Given the pivotal necessity of mobilization of groups and agendas after a disaster, the discussion of new and old ideas is the key point of the process in Birkland's theories. The accumulation of learning can happen also without discussions but is a very partial improvement in the flow. Also Pelling and Dill (2010) highlighted two viewpoints related to the political aspects of disasters and path dependency: disasters as catalysts of changes (quoting Olson & Gawronski, 2003), and disasters as producers on an "accelerated status quo" (referring to N. Klein, 2007). Also according to Johnson et al. (2005), the role of events in triggering policy change for risk reduction has to be deepen analysed (§Ch.1.4): during times of catalytic change, the number of issues negotiated and the range of actors involved increase and attention is higher, speeding up the rate at which policy changes. It's not the event that influences *per se* the mode of change, but its effect on the complex coalitions: the potentially transformative role of the shock events relies on a combination of contextual, behavioural and environmental drivers related to institutions, technology available, individuals and social organization. Looking at change in the light of the complex and dynamic relation between scientific knowledge and policy design, it's here assumed that the science-policy interface and the knowledge transfers is not a "transfer" of knowledge from science to policy (Spray et al., 2009, p. 165) and evidence and facts do not represent the pillars of policy-making (Landry et al., 2001, as quoted by Mitton et al., 2007, p. 741). The relation between environmental sciences and policies is not immune to the mentioned controversial points: "It may be relatively uncontroversial to propose that environmental policies informed by an understanding of the relevant natural and social systems are more likely to achieve their goals than those that are not. However, the principles and practice of 'evidence-based policy' are rather more contested" (Holmes & Clark, 2008, p. 703). According to the author, some factors that can be very influential on "who learns" and "what is learned" – even more than research results themselves – are (inspired by Mitton et al., 2007):

- the fragmented competences and behavioural inclination of knowledge producers and users can trigger or slow down the process
- multiple actors are involved in the decision-making process and often work on different time frames (e.g. research makers and policymakers)
- the use of research outcomes (above all of innovative research) is a multi-stage cumulative process: consequently, the complexity of science is typically translated into short-comings
- institutional constraints and attitude push for "research-that-fits-in"
- competing interests look for "research-that-matches-the-beliefs"

These notions are here used to further investigate tools and policies of risk reduction and adaptation, since the role of knowledge transfer and of 'evidence-based policy' are evidently quite relevant aspects for achieving long-term results. According to the *policy streams* approach (Kingdon, 1995) and Birkland's model in Figure 6, "policy windows of opportunity" open up facilitating policy change and innovation in critical times, namely when: problems are recognised, solutions are available and political climate is receptive. The "window of opportunity" after a shock – in policy studies and disaster studies – is influenced by the acceleration of the decision-making process, and interferes with the process of change that can be recognised afterwards (Kingdon, 1995; Birkmann et al., 2010). This window of opportunity becomes visible through several and interrelated factors, such as the increased social and political awareness following a disaster, the enlargement of actors engaged in the debates, the funds made available to start the reconstruction. The issue of how ruinous events trigger (or not) changes represents an interesting lens for evaluating the disaster cycle and for understanding lessons learned and capabilities built, towards hopefully more resilient communities and places, even if dualistic effects and negative externalities can't be evaded (Birkmann et al., 2010)[17].

An element needs to be added to the framework: time. "Time" is a scarce resource above all in post-disaster recovery: "stakes are high, participants are under stress, and political tensions are amplified" (R. Olshansky & Chang, 2009). More precisely, "post-disaster environments show a compression of urban development activities in time and in a limited space" (R. B. Olshansky et al., 2012, p. 173). The notion of "time compression" enlighten and exacerbate the tension between "speed" and "deliberation": between the pressure for acting quickly – to rebuild infrastructures, supply to fundamental needs, avoid further losses – and the quality of the choices in terms of efficient planning and deliberation for introducing beneficial changes and optimize that "window of opportunity", involving equity issues, power relations, interactions, and so forth (R. Olshansky & Chang, 2009; R. B. Olshansky et al., 2012; Bulkeley, 2013; Platt & So, 2016). The "pre-existing city" is in people's minds, conflicting with the plan for the future: "It is the conflict between these two plans that must be resolved, and in a short time, so as not to lose the functional capabilities of the first plan and the mitigation and improvement possibilities of the future plan" (R. Olshansky & Chang, 2009, p. 207).

[17] Disasters' impacts "are passive – received by a social actor; change is active (though not necessarily consciously chosen) and can be reflexive (spontaneous, automatic, not thought through) or reflective (strategic, planned, thought through) (Beck, 1998, as quoted by Birkmann et al., 2010, p. 41).

The tendency to reconstruct "the pre-existing cities" cited above – following the mantra *"com'era dov'era" ("as it was, where it was")*[18] – characterize each post-disaster reconstruction in Italy, especially in post-earthquake recovery. Learning from "low-probability/high-consequences" events is challenging because of the medium-long return time of these events and the implicit urgency in the aftermath: in this phase, to "do something" may be more politically profitable than engaging in a more cautious, effective and valuable deliberation (Birkland, 2006, pp. 7-8). The effect of the "time compression" and the tensions between speed and deliberation influence the post-event policies likewise. Post-disasters policy windows (that do not stay open for long) can offer the potential for policy changes: the actors involved act as forces inside the policy window, moving logically from their own *pre-existing* ideas, beliefs and values. The increase of attention after the event is "the complement of the disproportionate lack of concern and attention to the problem before the event. This increased attention does not necessarily mean that learning will occur" (Birkmann et al., 2010, pp. 10-11): shocking events represent anyhow a breaking point of the status quo putting an issue on the agenda, and the accelerating role of major events relies mainly on how such events force larger groups of actors to engage in a debate and "to compete", to elevate and keep seriously the new interests on a new policy agenda, as in Figure 6. The quality, intensity and results of the debate obviously vary: this "augmented reality" can lead to a shift towards models, values, techniques and so forth, and this shift depends on the outputs of the tensions.
Figure 7 recompose the theories debated above. Decisional processes are therefore developed by multiple actors in a more or less clear temporal scale (T) and involving rather distinguishable spatial scales (S). Ideally, decision-making should be guided by knowledge produced in the domain (in this case, in the multiple fields related to resilience, risk reduction and adaptation) as result of a "learning process", and be oriented towards a new and more effective governance by the design and implementation of oriented collaborations, strategies and plans (from fostering anticipatory adaptation to build preparedness to face adverse events). During and after a shock, T and S are clearly compressed (T' & S', T'' & S''): the policy window in which actors negotiate the policy response is guided by urgency, and concentrated in specific areas. Therefore, the debates and policy responses tend to exploit all the knowledge available about disaster management to face essential needs primarily, and afterwards they launch a recovery strategy, whose form, tools and goals are highly context-dependent. If existing procedures, rules, projects and tools are available at close hand after a ruinous event, they may be used immediately – even if found inadequate. The most available options risks to win over the most adequate ones. This emphasises again the necessity of engagement in day-to-day experimentation of risk reduction activities and policies.
The theoretical framework so defined is sketched in Figure 7:

[18] This phrase acquired fame after the earthquake that struck Friuli area (North-East Europe) in 1976, recognised as a successful reconstruction. It is further explored all along the thesis. The expression summarised the hope to overcome the tragedy and allow communities to restart "as before" the earthquake (Nimis, 2009). The success of Friuli's reconstruction is generally attributed to the close collaboration between professionals of the building sector and public officials, and to the strong synergies and cooperation of all the subjects involved in the operations (Mazzoleni & Sepe, 2005).

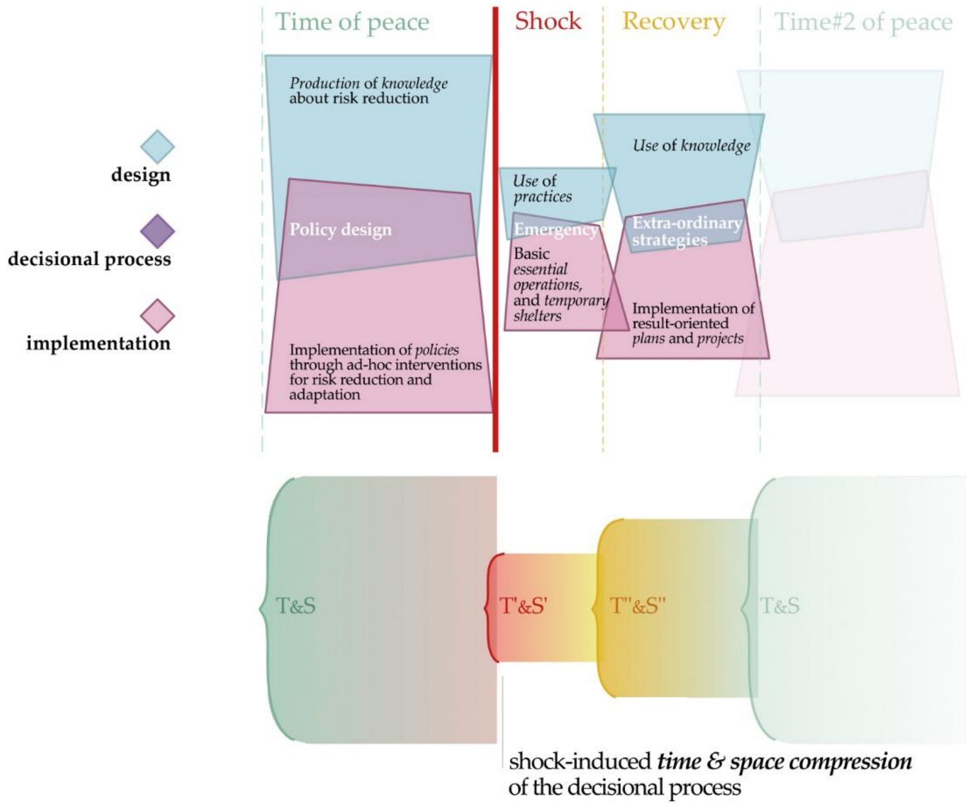

Figure 7. The knowledge-policy interface adapted to the disaster cycle. Elaboration of the author.

As described in §Ch.1.3, research on risk reduction has recognised the role of spatial planning and urban projects in influencing the levels of risks, interfering with the key relationships that affect the reduction or exacerbation of natural hazards through infrastructural and technological measures, specific urban design technics, building codes, land-use plans, development strategies etc. (Fera, 1991; Menoni, 2005; Cremonini & Galderisi, 2007; Esteban et al., 2011; Wamsler, 2014). Post-disaster planning has been even defined as a "sped-up version of the normally difficult processes of urban planning" by R. Olshansky and Chang (2009, p. 207), a point of view strongly embraced by the author also for professional personal experience[19]. The research therefore look at how the reduction of seismic and hydrogeological risks is framed in Italy, analysing important planning and policy ordinary and extra-ordinary post-event interventions, since "risk reduction struggles to go beyond fragmented interpretations, regulations and plans, that debate about it as a topic in unstable balance between civil protection, planning and environmental protection" (Di Giovanni, 2016a, p. 56). The theoretical framework defined by this thesis – by merging literature about risk reduction and resilience, disaster studies and policy change – leads the investigation on the cases, with the purpose of understanding the choices, inertia and changes that followed nature-related disasters in Italy, and especially the weight of the pre-existing policies and plans in shaping the re-action after the crisis in terms of previous values, projects and policies, questioning consequently the use of the "window of opportunity" as triggers of technological and policy change. The research looks therefore at how learning processes and science-policy interfaces for adapting to risk – which cross all the phases of the disaster cycle – have influenced the recovery phase.

[19] She took part to the definition of post-reconstruction plans after Abruzzo's 2009 earthquake.

2.2 METHODOLOGY

The nature of this research is mainly exploratory-explanatory, and the research approach was inspired by different bodies of literature and theories related to *applied research*, both in terms of research engagement and knowledge production, and with the purpose of enriching and applying knowledge to inform action and enhance decision making.
The 'Mode 2' knowledge production approach, as described by Wamsler (2007, p. 38) referring to pivotal works of Gibbons et al. (1994) and Nowotny, Scott, Gibbons, and Scott (2001), put the identification of local problems at core stage of the research activity, which is grounded on the synergies between science and social mission and requires a transdisciplinary perspective. "The old paradigm of scientific discovery ('Mode 1') – characterized by the hegemony of theoretical or, at any rate, experimental science; by an internally-driven taxonomy of disciplines; and by the autonomy of scientists and their host institutions, the universities – was being superseded by a new paradigm of knowledge production ('Mode 2'), which was socially distributed, application-oriented, trans-disciplinary, and subject to multiple accountabilities" (Nowotny, Scott, & Gibbons, 2003, p. 179).
Because of its focus, the research interfaces between different disciplinary boundaries, but based on an urban planning point of view (being the author an urban planner), enriched by disaster studies and political studies.
As described by Yin, "case studies are the preferred strategy when "how" and "why" questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life context" (Yin, 2008, p. 1).
The research is focused on Italy: the selection of cases comes from personal interests, but it's validated by the evidence offered by science and national history. The work proposes two different use of case studies:

i. at a national scale, to investigate the complex nature-related risk-prone features of the Italian territory and the normative and policy frameworks addressing risk reduction (§Ch. 3)
ii. at the urban scale, to analyse locally the specific conditions of the national picture through two relevant examples: the cities of Genoa (§Ch.4) and L'Aquila (§Ch.5).

Italy (§Ch.3) is imagined as "a case study": the Italian territory is inherently fragile and with a strong propensity to earthquake, landslides and floods, where special morphological conditions have been amplified by land consumption and abandonment of mountain areas and deforestation, a not incisive planning system, spread unauthorised urbanizations. The necessity of engagement in wide policies of risk reduction and adaptation, also to better frame future reconstructions, is demonstrated by scientific data and past and recent national "disaster history". New national-scale interventions and funding policies introduced since the early 2010s and are here investigated as occasion (or not) for introducing a cultural shift towards long-term proactive approaches for risk reduction.
The city of Genoa (§Ch.4) is affected by extremely severe hydrogeological instabilities and represents an emblematic case of recurrent floods (aggravated by landslides) in urban contexts, exacerbated by decades of massive urbanization. The city has experienced major floods all along its history: focusing only on the floods since the first '90s until 2014, damages for more than 1,4 billion euros have been evaluated. In 2011 and 2014 the floods killed 7 people, a baby girl

included. The research focuses on the ongoing projects to reduce flood risk along Bisagno and Fereggiano streams across the city, retracing their origins, characteristics, bottlenecks and innovative potential for contributing effectively (or not) to a more flood-resilient Genoa.
L'Aquila (§Ch.5) is the last city – after Messina (Sicily) in 1909 – that has been destroyed by an earthquake, in April 2009. An enormous reconstruction process is still undergoing in the city and in the other 56 neighbouring minor municipalities that were strongly damaged, counting 309 deaths and 1600 wounded. The complex "governance of the reconstruction" – in terms of planning tools, ad-hoc legislative frameworks and institutional co-organization put in place since 2009 – is here investigated as ambitious process able to exploit (or not) the huge resources mobilized, and fostering (or not) risk reduction measures together with necessary new development goals.
The different nature of risks involving the two cities is a choice of the author: it makes the cases complementary in the overall aim of the research, making possible to more widely challenge the research questions and validate the assumptions.
Coherently with what stated above, the research questions were firstly defined after an exploratory review of the literature and progressively clarified through direct investigation on the cases, always nurtured by the theoretical background. Qualitative methods were considered the appropriate and essential approach to develop the investigation, allowing questions and issues to emerge from the cases crossing different disciplines, and to better encompass the complex technical and political dimensions that the study aims to understand.
The research activities mixed desk studies and active observation, favouring:

i. documental analysis of projects, policy reports, legislation
ii. semi-structured interviews with qualified informants, especially: Chief Officials in key positions in local and central institutions and public authorities; City Council members; university professors and researchers engaged in the policies and plans investigated.
iii. participation in technical specialized seminars and workshops
iv. dedicated fieldworks
v. participant observation

The framework derived from disaster studies sketched in §Ch.2.1 guides the examination of the case studies; vice versa, the latter are used to confirm, nuance or discard the framework itself, and to contribute to a better understanding of potential, criticalities and bottlenecks of current governance, policies and plans in enhancing risk reduction and adaptation.

A brief appendix provides an overview of a very recent experience in the realm of flood risk-reduction ongoing in North Europe, the international "Building with Nature" (BwN) Interreg project[20]. BwN project tests nature-based solutions for flood risk reduction and coastal protection: during visiting periods at the IHE Delft Institute for Water Education[21], the author was involved in preliminary meetings and studies. The appendix offers a brief report of the first phases of the project, which confirm the assumptions explored in the theoretical framework of this thesis and investigated in the cases.

[20] BwN is part of the European Interreg Vb North Sea Region Programme 2014-2020 ("Sustainable North Sea Region") co-financed by the European Regional Development Fund (www.northsearegion.eu/building-with-nature).

[21] IHE Institute – formerly UNESCO-IHE Institute for Water Education – is among the main partners of the Project, responsible of the work package for "Upscaling: Practice, Policy and Capacity Building".

PART II. EXPLORING RISK REDUCTION AND ADAPTATION IN CITIES: THE ITALIAN CASE(S)

CHAPTER 3

Fragile Italy

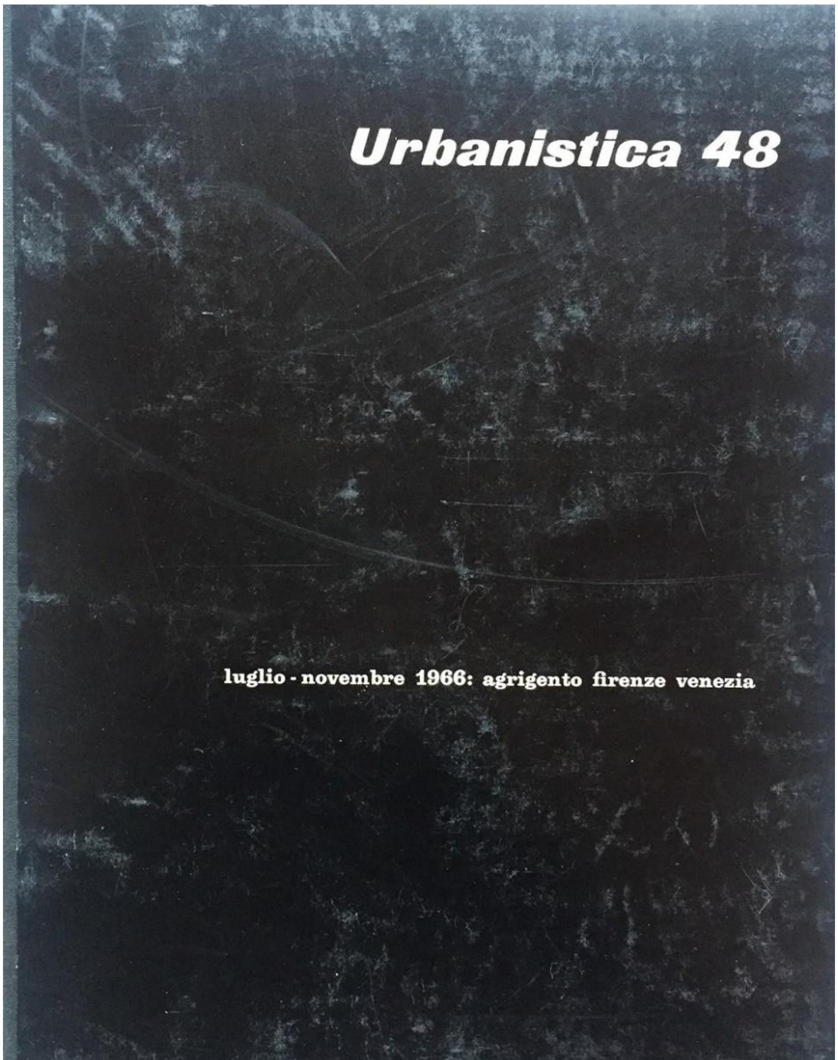

Figure 8. Cover of Issue 48 of *Urbanistica* (journal of the National Istitute for Urban Planning INU), edged in black as symbol of mourning for the disasters occurred in Agrigento, Florence and Venice in 1966. The Director's editorial underlined the strong relation between planning deficiency and the national catastrophes (Astengo, 1966).

3.1 THE SEISMIC AND HYDROGEOLOGICAL RISKS

The Italian territory is inherently fragile, with a strong propensity to earthquakes, landslides and floods. Italy is one of the most earthquake-prone countries in the Mediterranean, due to its geographical position in the area of convergence between the African and the Eurasian tectonic plates. Since 1900, more than 50 strong earthquakes with a Momentum Magnitude (M_w) superior to 5,5 and an Epicentral Intensity MCS (I_o) superior to 7 struck Italy (Rovida, Locati, Camassi, Lolli, & Gasperini, 2016; Valensise, Tarabusi, Guidoboni, & Ferrari, 2017)[22]. Mountainous or hilly regions make the 75% of the country (Trigila et al., 2015, p. 3) and this complex orography predisposes the territory also to hydrogeological instability: Italian basins are generally small in size and characterized by extremely fast response to rainfall; furthermore, the 7,3% of the national territory is affected by landslides (Trigila et al., 2015, p. 3). These peculiar morphological and geological conditions are amplified by forms of land consumption and overexploitation – about 9% of land consumption in Italy involves areas threatened by hydraulic hazards (Munafò et al., 2015, p. 29) –, lack of restoration and maintenance of slopes and waterbeds, abandonment of mountain areas and deforestation, a not incisive planning system, spread unauthorised urbanizations. This fragility is widely documented by scientific literature, ongoing research, freely available reports and data. Assuming the notion of risk described in §Ch. 1.1, a synthetic portrayal of the territory is depicted in this chapter: *high landslide hazard*[23] concerns 8% of Italian territory for 1.224.000 inhabitants, and more than 4% of the territory is subject to *high hydraulic hazard*[24] involving 1.915.000 inhabitants (Trigila et al., 2015). Percentages rise when referring to *high seismic hazard*[25] that involves around 45% of the national surface and more than 24 million inhabitants (41% of the total population). These hazards involve not only rural or mountain areas but also urban systems. Assessing the *vulnerability* of urban fabrics is an extremely complex and multidisciplinary task, but the fragility of Italian residential and industrial urban fabrics is widely testified: firstly by the self-explanatory history of the country – Italy has always been struck by nature-related disasters, and has one of the highest numbers of disasters in the Mediterranean area (Guidoboni & Valensise, 2014a, p. 7), and it is the seventh country in the world in terms of absolute losses between 1998-2017 (UNISDR & CRED, 2018, p. 4) – and secondly, by large academic research, scientific and grey literature dedicated to this field of investigation (quoting only recent references, among many others: Guidoboni & Valensise, 2014a; Molinari et al., 2014; Silvestro et al., 2016; Struttura di Missione Casa Italia, 2017; Valensise et al., 2017). Italy presents also a high *exposure*, due to population density and to the large number

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[22] Epicentral Intensity equal to 7 on the Mercalli-Cancani-Sieberg scale (MCS) identifies “very strong” earthquakes, able to provoke slight damages also in well-built buildings. A $M_w \geq 5.5$ indicates “potentially damaging” earthquakes in Italy according to expert scientific literature (as indicated by Valensise et al., 2017). The Parametric Catalogue of Italian Earthquakes (Rovida et al., 2016) covers the time period 1000-2014: filtering earthquakes from year 1900 with $I_o \geq 7$ and $M_w \geq 5.5$, the online catalogue reveals 48 earthquakes. Data about the disruptive seismic sequence that struck Central Italy in 2016-2017 are provided by Valensise et al. (2017).

[23] “High landslide hazard” refers to zones coded with “high” (P3) or “very high” (P4) level of landslide hazard according to the Plans for Hydrogeological Systems (PAI) (Trigila et al., 2015, pp. 9-10, 72)

[24] “High hydraulic hazard” refers to areas with “high” level of flooding hazard, coded as P3 zones according to the DLgs. 49 (2010) for the implementation of the European Floods Directive 2007/60/EC (Trigila et al., 2015, pp. 37, 110).

[25] Data elaborated by the author, selecting census data (Italian National Institute of Statistics ISTAT - national census 2011, http://dati-censimentopopolazione.istat.it/Index.aspx) for areas with “high” or “medium” level of seismic hazard, coded as zones 1, 2, 2A and 2B according to Italian seismic classification.
The list of Italian municipalities classified according to the national classification is available at http://www.protezionecivile.gov.it/jcms/it/classificazione.wp, updated on March 2015.

of towns and cities built in risk-prone areas. The architectural and artistic heritage which constitutes a fundamental component of the Italian landscape is countrywide threated by natural hazards. Reports compiled by public agencies or leading research centres offer information and data about hydrogeological and seismic difficulties (AA.VV., 2007; Ministero dell'Ambiente e della Tutela del Territorio e del Mare, 2008; ANCE & CRESME, 2012; AA.VV., 2014; Munafò et al., 2015; Trigila et al., 2015). Data are mainly provided at regional or provincial level, without sub-classification, or focused on specific cities as samples (Galderisi & Limongi, 2017); the availability of open-access data at local scale is very recent, mainly from 2015. On August 2017 the Italian National Institute of Statistics (ISTAT) published online a freely accessible national dataset on nature-related risks (henceforth called "Istat Risk Dataset"[26]) that collects data at the municipal level.

In order to advance an overview of risks involving Italian cities, the author built a GIS to support data collection and elaboration; the research is focused on municipalities with more than 50.000 and 200.000 inhabitants[27] and on "metropolitan cities"[28], starting from OECD's definitions of "city"[29]. Italy counts 144 cities with more than 50.000 inhabitants, 16 with more than 200.000 inhabitants, and 14 Metropolitan Cities. Data about hydrogeological risks have been extracted from the Istat Risk Dataset, and further data about "artificial surfaces at risk" have been selected from ISPRA Report no. 233 (Trigila et al., 2015, pp. 101-109; 136-144). The selection was focused on population and areas exposed to "high" or "very high" landslide hazard[30] and "high" flooding hazard[31]. The author collected data about seismic risk firstly through the selection of municipalities with a "high" level of seismic hazard according to Italian seismic classification[32] (OPCM 3274, 2003). For these cities, the author selected data about population and building stock, precisely about maintenance status and construction age of residential buildings, highlighting buildings built before the introduction of the first national anti-seismic building standards (L. 64, 1974) and in bad preservation status[33]. The

[26] In 2015 the Report no. 233 was published by the Italian National Institute for Environmental Protection and Research (ISPRA) (Trigila et al., 2015) providing data about landslides and floods at municipal level. Its data were partially included in the "Istat Risk Dataset" that was elaborated for "Casa Italia", new-born Department of the Presidency of the Council of Ministers which was initially launched as a national program against risks of natural origin in August 2016 (§Ch.3.2). Istat Risk Dataset is available online at https://www4.istat.it/it/mappa-rischi/indicatori.

[27] The GIS uses the official administrative boundaries of municipalities, provinces, metropolitan cities and regions updated to 2016 (downloaded from ISTAT website http://www.istat.it/it/archivio/124086). Data about population are official intercensus data updated to 2015, available in "Istat Risk Database". The GIS was created using the free software QGis 2.8.

[28] L. 56 (2014) established "Metropolitan Cities" as new "local authorities": Bari, Bologna, Cagliari, Catania, Florence, Genoa, Messina, Milan, Naples, Palermo, Reggio di Calabria, Rome, Turin, Venice. The territory of every metropolitan city corresponds to the homonymous Province's one, with the only exception of Cagliari, whose extension is smaller including only 17 municipalities.

[29] OECD describes as "urban" a functional area with a population of 50.000 people at least; if the population is between 200.000 and 500.000 people, the urban area is defined "medium-sized" while larger populations generate metropolitan areas (OECD, 2012).

[30] In Istat Risk dataset and in Trigila et al. (2015), the estimation of the "population at landslide risk" was performed by intersecting areas with maximum hydrogeological hazard (zones P3 and P4 in Hydrogeological Plans PAI) with 2011 census local sections; the indicator about "artificial surfaces" at risk was developed through a cartographic overlay between hazard maps and land consumption maps (Trigila et al., 2015, pp. 3-24, 68-81). See also note 23.

[31] In Istat Risk dataset and in Trigila et al. (2015), the estimation of the "population at flooding risk" derived from the intersection of areas with maximum flooding hazard (zones P3 according to the DLgs. no. 49/2010) with 2011 census local sections; the indicator about "artificial surfaces" at risk was developed through a cartographic overlay between hazard maps and land consumption maps (Trigila et al., 2015, pp. 25-48, 110-117). See also note 24.

[32] Zones 1, 2, 2A and 2B of Italian seismic classification. See also note 25.

[33] ISTAT census offers data about the condition of residential buildings for each municipality. Consequently, selected data concern pre-1970s buildings and buildings in bad/very bad preservation status, structures – hypothetically –

same analyses were carried out for Metropolitan Cities, focusing on the only sub municipalities subject to seismic hazard. Table 3 and Table 4 summarise the main results; the map in Figure 9 illustrates the geographical distribution of hazards and their overlay in the same urban contexts.

	Cities and Population	**High seismic risk** num. of seismic cities, related population and residential building stock		**High/Very High landslide risk** cities subject to landslides, population and artificial surface		**High flood risk** cities subject to floods, population and artificial surface	
Municipalities with more than 50.000 inh.	*144 cities* *20.919.478 inh.*	**68 cities** **10.125.043 inh.**		**94 cities** **193.510 inh.** at landslide risk	1,3% of population	**124 cities** **662.667 inh.** at flood risk	3,4% of population
		550.967 pre-1970 residential buildings	54% of building stock of seismic cities	700 sq. km. subject to landslide hazard	4,2% of municipalities' surface	1.654 sq. km. subject to flood hazard	7,7% of municipalities' surface
		198.534 residential buildings in bad/very bad preservation status	20% of building stock of seismic cities	32 artificial sq. km. at landslide risk	1,5% of total artificial areas	150 artificial sq. km. at flood risk	5% of total artificial areas
Municipalities with more than 200.000 inh.	*16 cities* *10.123.122 inh.*	**5 cities** **5.066.234 inh.**		**11 cities** **86.045 inh.** at landslide risk	1,1% of population	**16 cities** **236.063 inh.** at flood risk	2,3% of population
		173.916 pre-1970 residential buildings	60% of building stock of seismic major cities	129 sq. km. subject to landslide hazard	4,6% of municipalities' surface	201 sq. km. subject to flood hazard	5,1% of municipalities' surface
		69.706 residential buildings in bad/very bad preservation status	24% of building stock of seismic major cities	7,4 artificial sq. km. at landslide risk	1% of municipalities' artificial areas	30 artificial sq. km. at flood risk	3% of municipalities' artificial areas
Metropolitan Cities	*14 metropolitan cities* *21.952.981 inh.*	**8** **metropolitan cities** **10.553.392 inh.** in seismic sub-municipalities		**13** **metropolitan cities** **309.642 inh.** at landslide risk	1,5% of metropolis' population	**14** **metropolitan cities** **567.535 inh.** at flood risk	2,6% of metropolis' population
		797.707 pre-1970 residential buildings	54% of building stock of seismic metropolitan cities	2.814 sq. km. subject to landslide hazard	6,4% of metropolis' surface	2.030 sq. km. subject to flood hazard	4,4% of metropolis' surface
		360.776 residential buildings in bad/very bad preservation status	24% of building stock of seismic metropolitan cities	78,3 artificial sq. km. at landslide risk	2,5% of metropolis' artificial areas	146,4 artificial sq. km. at flood risk	3,8 % of metropolis' artificial areas
Italy	*60.665.551 inh.*	*25.000.908 inh. living in seismic municipalities*	*41% of national population*	*1.247.679 inh. at landslide risk*	*2,1% of Italy's population*	*1.915.236 inh. at flood risk*	*3,2% of Italy's population*
		6.911.180 pre-1970 residential buildings	*54% of total building stock*	*23.929 sq. km. subject to landslide hazard*	*7,9% of Italy' surface*	*12.218 sq. km. subject to flood hazard*	*4% of Italy' surface*
		2.051.808 residential buildings in bad/very bad preserv. status	*17% of total building stock*	*476,3 artificial sq. km. at landslide risk*	*2,7% of Italy' artificial areas*	*673,3 artificial sq. km. at flood risk*	*3,8% of Italy' artificial areas*

Table 3. Italian cities at seismic and hydrogeological risks. Population data refer to 2011 and 2015. Elaboration of the author from data available in Istat Risk Dataset and Italian Seismic Classification and Ispra Report no. 233.

more vulnerable to earthquakes by comparison with the most recent ones. Data were selected from Istat Risk Database.

Municipalities with more than 200.000 inh. and Metropolitan Cities	Inhabitants 2015	High seismic risk			Very High/High landslide risk		High flood risk	
		Inhabitants at risk [A]	% of residential building stock [B] pre-1970	% of residential building stock [B] in bad/very bad preserv. status	Inhabitants at risk	% of artificial surfaces [C] at risk	Inhabitants at risk	% of artificial surfaces [C] at risk
Rome	2.864.731	100%	53%	13%	375 (≈0%)	0,01%	21.102 (0,7%)	2,7%
Rome Metropolitan City	*4.340.474*	*3.863.448 (89%)*	*47%*	*15%*	*18.926 (0,4%)*	*0,6%*	*40.644 (0,9%)*	*2,3%*
Milan	1.345.851	-	-	-	-	-	29.711 (2,2%)	2,4%
Milan Metropolitan City	*3.208.509*	-	-	-	*4 (≈0%)*	-	*43.703 (1,4%)*	*1,3%*
Naples	974.074	100%	68%	40%	45.943 (4,7%)	3,3%	226 (≈0%)	0,1%
Naples Metropolitan City	*3.113.898*	*2.866.804 (92%)*	*52%*	*25%*	*101.000 (3,2%)*	*3,3%*	*28.817 (0,9%)*	*0,9%*
Turin	890.529	-	-	-	530 (0,1%)	0,1%	1.350 (0,2%)	0,4%
Turin Metropolitan City	*2.282.197*	-	-	-	*29.772 (1,3%)*	*3,2%*	*31.142 (1,4%)*	*2,9%*
Palermo	674.435	100%	66%	27%	5.663 (0,8%)	1,9%	8.394 (1,2%)	1,3%
Palermo Metropolitan City	*1.271.406*	*1.271.406 (100%)*	*52%*	*27%*	*16.919 (1,3%)*	*1,7%*	*12.292 (1%)*	*0,8%*
Genoa	586.655	-	-	-	29.769 (5,1%)	6,9%	49.165 (8,4%)	6%
Genoa Metropolitan City	*854.099*	-	-	-	*68.734 (8%)*	*14,7%*	*86.658 (10,1%)*	*5,7%*
Bologna	386.663	-	-	-	412 (0,1%)	0,6%	3.964 (1%)	1,2%
Bologna Metropolitan City	*1.005.831*	*152.760 (15%)*	*59%*	*11%*	*15.664 (1,6%)*	*4%*	*92.211 (9,2%)*	*13,6%*
Florence	382.808	-	-	-	1.570 (0,4%)	0,5%	12.121 (3,2%)	3,3%
Florence Metropolitan City	*1.013.348*	*86.928 (9%)*	*72%*	*13%*	*22.186 (2,2%)*	*4,5%*	*51.051 (5%)*	*4,6%*
Bari	326.344	-	-	-	339 (0,1%)	0,1%	1.506 (0,5%)	1%
Bari Metropolitan City	*1.263.820*	-	-	-	*3.635 (0,3%)*	*0,1%*	*14.827 (1,2%)*	*1,5%*
Catania	314.555	100%	69%	38%	213 (0,1%)	0,04%	480 (0,2%)	2,7%
Catania Metropolitan City	*1.115.535*	*1.115.535 (100%)*	*54%*	*27%*	*6.910 (0,6%)*	*0,3%*	*1.103 (0,1%)*	*1%*
Venice	263.352	-	-	-	-	-	55.650 (21,1%)	8,4%
Venice Metropolitan City	*855.696*	-	-		-	-	*135.381 (15,8%)*	*13,9%*
Verona	258.765	-	-	-	-	-	12.338 (4,8%)	3,4%
Messina	238.439	100%	64%	35%	697 (0,3%)	0,5%	1516 (0,6%)	0,8%
Messina Metropolitan City	*640.675*	*640.675 (100%)*	*64%*	*28%*	*8.546 (1,3%)*	*1,5%*	*4.653 (0,7%)*	*0,7%*
Padua	210.401	-	-	-	-	-	38.358 (18,2%)	16,5%
Trieste	204.420	-	-	-	534 (0,3%)	0,2%	103 (0,1%)	0,2%
Taranto	201.100	-	-	-	-	-	81 (≈0%)	1,4%
Reggio di Calabria Metrop. City	*555.836*	*555.836 (100%)*	*59%*	*31%*	*16.571 (3%)*	*2%*	*16.581 (3,9%)*	*4,2%*
Cagliari Metropolitan City	*431.657*	-	-	-	*775 (0,2%)*	*0,4%*	*8.472 (2%)*	*3,2%*

[A] In metropolitan cities, whole numbers refer to the population of the only seismic municipalities; percentages are referred to the total metropolitan population. [B] In metropolitan cities, percentages refer to the building stock of the only seismic municipalities, for the accuracy of the data. [C] Percentages refer to the total of "artificial surfaces" of each municipality or metropolitan city.

Table 4. Disaggregated data about Italian cities with more than 50.000 and 200.000 inhabitants and Metropolitan Cities. Elaboration of the author from data available in Istat Risk Dataset, Italian Seismic Classification and Ispra Report no. 233. Population data refer to 2011 and 2015.

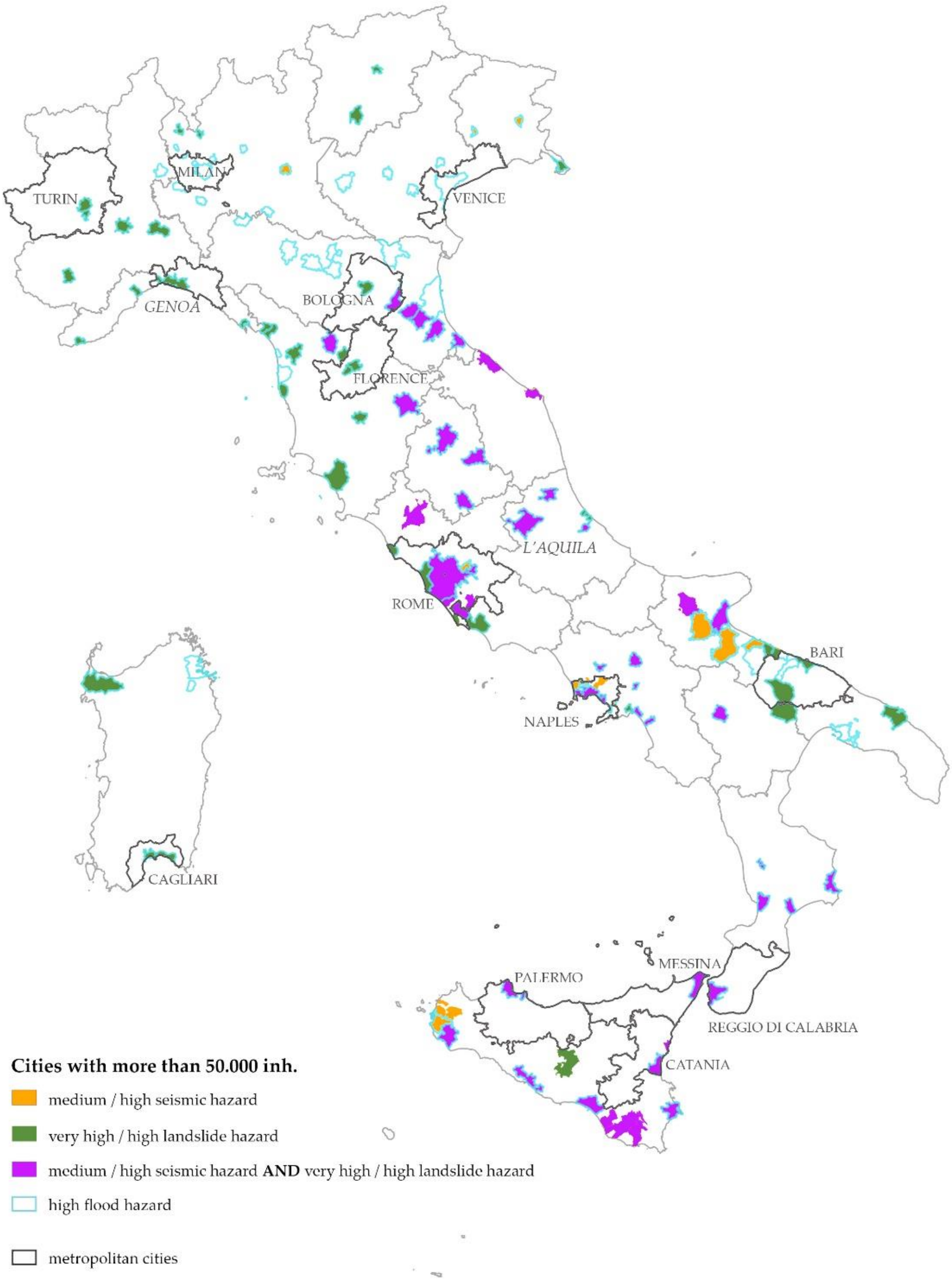

Figure 9. Municipalities with more than 50.000 inhabitants, with severe hydrogeological and seismic criticalities. Elaboration of the author.

Data in Table 3 show how the great part of Italian principal cities is subject to very significant hazards. Specific results about population and artificial surfaces at risk, together with the quality of the building stock, highlight the factual risks involving Italian urban systems. Seismic risk involves more than 10.000.000 people in cities, where more than 20% of the building stock is in a poor maintenance status and more than 50% is antecedent to the seismic regulations. High landslide risk affects smaller areas and population, but nonetheless it is a significant threat,

involving more than 190.000 inhabitants in cities and more than 300.000 inhabitants if we expand the analysis to metropolitan territories. High flood risk is the most present in Italian cities: it affects the 86% of cities with more than 50.000 inhabitants, and the 100% of the most populated cities. The artificial surfaces at high risk are more than 3% in all the cases.
Disaggregated data in Table 4 offer a portray of each major city and each "metropolitan city" (see note 28). High seismic risk, and potentially risky built environments, characterizes mainly southern urban systems, as shown by the outstanding data about Naples, Palermo and Messina (both at city and metropolitan scale) and the entire Reggio di Calabria Metropolitan City. Furthermore, the values are conspicuously higher than national average (in Table 3). High landslide risk affects especially Naples and Genoa (both at urban and metropolitan levels) and Florence Metropolitan City in terms of percentages of people and artificial surfaces involved; analysing the absolute values, landslide risk affects large population in several other cases as Palermo (5.663 inhabitants), or Rome and Turin Metropolitan Cities (18.926 and 29.772 inhabitants). High flood risk affects mainly northern cities, as Genoa, Padua, Verona, Bologna Metropolitan City, and Florence and Venice both at urban and metropolitan scale. Absolute values highlight very significant flood risk also for two main Italian cities: Rome and Milan.

3.2 GOVERNING RISK REDUCTION: BETWEEN REACTIVE APPROACHES AND INNOVATIONS

The normative evolution

Research on risk reduction has recognised the role of regional and urban governance and planning in influencing the levels of risks, reducing or exacerbating natural hazards through infrastructural and technological measures, specific urban design technics, building codes, land-use plans etc. (Fera, 1991; Menoni, 2005; Cremonini & Galderisi, 2007; Esteban et al., 2011). With reference to Italian history, many calamities have led to accusations of failures in territorial governance, leading towards new laws (or revisions of existing ones) in the direction of stricter rules and standards, in line with the theories presented in §Ch.1.1 and 1.3 about reactive approaches. The regulatory framework is summarized later on, in Figure 10.
The first main laws addressing the problem of stability of urban centres date back to the first decade of the XX century (L. 445, 1908; RD. 193, 1909); these acts introduced rules for the consolidation of landslides threatening villages, for the transfers of settlements and the prohibition of new constructions upon unstable lands. The current national law on urban planning dates back to 1942 (L. 1150, 1942) and was modified in 1967 (L. 765, 1967) to achieve a larger control on urban development: this legislative reform was influenced by the catastrophic events of 1966, namely the landslide in Agrigento (Sicily) and the floods in Northern and Central Italy. The floods gave birth also to the "Inter-ministerial Commission for the Study of Soil Defence and Hydraulic Works", known as the "De Marchi Commission", which produced a national program of interventions and criteria for land protection – based on a multidisciplinary approach to natural resources management – to be implemented over the following thirty years through basin-scale plans. The principles introduced by De Marchi Commission between 1967 and 1974 finally led to the Law for Land Defence in 1989 (L. 183, 1989): it represented the first attempt to introduce an integrated approach among soil, water and planning, through "Basin Management Plans" and the introduction of "River Basin

authorities"[34]. Law no. 183 was not effectively applied until the end of 1990s when the landslide in Sarno (1998) and the flood in Soverato (2000) led to the rapid enactment of new laws for speeding up both the prevention of hydrogeological risk imposing a national mapping of landslide risk, and the implementation of Basin Management Plans (L. 267, 1998; L. 365, 2000). Basin Management Plans are superordinate to local urban spatial plans: therefore, policies in existing and future spatial planning plans at municipal level are required to be consistent with the indication of the Basin Plans, especially regarding the location of hazard-prone areas. Progressively between the 1970s and 1980s, the relationship between seismic&hydrogeological risks and planning activities became direct, introducing special technical standards for building in seismic zones and requiring geomorphological assessments for urban plans (assessments necessary both to verify existing plans, both to adopt new ones) (L. 64, 1974; L. 741, 1981; DM. 11 march, 1988). In detail, law no. 64 introduced the first national seismic code – to be applied only to new constructions – and imposed a verification of the "geomorphological compatibility" of new town plans "in case of municipalities located in seismic zones". Until the 1980s, the seismic classification of the country was based on the praxis of mapping previous earthquakes, running after the event: the disasters acted as indicator of the seismic hazard[35]. Revisions of the normative framework and of the seismic classification evolved after Irpinia's earthquake (1980)[36] until 2000. The first national classification entered into force in 1984 classifying the country according to 3 areas of risk and leaving large areas as "unclassified". After the earthquake in Umbria and Marche in 1998, a most appropriate concept of anti-seismic classification and prevention has been imposed: a revision of the national classification started, and Law no. 61 introduced a focus on the urban scale of the reconstruction, going beyond the building restoration (L. 61, 1998)[37]. Studies for the re-classification were finalized in 2003 after the earthquake occurred on 31st October 2002 in Molise and Puglia: a deep revision of the national seismic classification and a new update of the building seismic codes were introduced by the Ordinance of the President of the Council of Ministers (OPCM 3274, 2003): with 2003 classification the country has been declared as "entirely exposed at seismic hazard" according to 4 levels of seismicity. The same regulation stated that the nature of the soil affects the seismic motion, influencing local seismic risk, and imposed a revision for the town plans of municipalities whose seismic classification was changed. The new "National Building Codes" – which include specific anti-seismic regulation – was published in 2008 (DM. 14 gennaio, 2008) and early applied in 2009 soon after L'Aquila earthquake (updated again in January 2018). In September 2008, guidelines for seismic microzoning were defined with the purposes of contributing to local knowledge about seismicity, reducing seismic risk, providing criteria for planning (ANCE & CRESME, 2012; Gisotti, 2012; Ghirotti, 2014): the Ordinance of the Chief of the National Department of Civil Protection OCDPC. 52 (2013) added the analysis of the so-called C.L.E. "Limit Condition for

[34] The River Basin authorities have been reorganised as River District Authorities according to the National Environmental Code (D.Lgs. 152, 2006), which unified the legislation about land defence incorporating also the European Directive on water (2000/60/EC); the reorganization was finalised in 2017 (D.M. Ministero dell'Ambiente e della Tutela del Territorio e del Mare, 2016).

[35] Dozens of municipalities asked revisions of the classification for being declared "non-seismic" (Meletti, Stucchi, & Calvi, 2014, p. 14).

[36] After 1980 earthquake, Law no. 741/1981 attributed to Regions the power to establish further rules and criteria regulating the design and update of planning instruments with the goal of reducing seismic risk.

[37] Law no. 61 tried to introduce "integrated programs of recovery" aimed at the rehabilitation and recovery of towns hit by earthquakes or exposed to hydrogeological hazards. Umbria Regional Law on Planning is one of the most advanced in Italy, as detailed forward.

Emergency" to seismic microzoning studies. The analysis of C.L.E. is focused on strategic buildings and infrastructures whose correct functioning is vital during emergencies, aiming therefore at a stronger integration among planning interventions and emergency functions and management interventions (Fabietti, 2013; Olivieri, 2013)[38]. After Abruzzo's earthquake (2009), special funds have been designated for a "national plan for the prevention of seismic risk" (L. 77, 2009), overseen by the National Department of Civil Protection.

Differently from anti-seismic building codes, there is no comprehensive code or technical regulation at the national scale to promote flood or landslide risk reduction "daily" in building and spatial transformation, guided mainly by assessment of compatibility between transformation proposes and eventual hazards present in the area, regulated at regional or local scale. A novelty was introduced in 2010 by the Legislative Decree no. 49 that introduced the Flood Management Plans required by the European Floods Directive (2007/60/EC) (DLgs. 49, 2010). Flood Management Plans propose a more comprehensive policy addressing flood risk, involving both the scientific and governance aspects of risk reduction, requiring (quoting only the main themes): the mapping of risks – and not just hazards; interinstitutional cooperation among District authorities, Civil Protection and Regions; integrated intervention involving both structural measures aimed at hazard control, and vulnerability reduction.

Responsibilities about flood risk governance at local levels have been reframed also in 2014 by Law no. 56 and 116: the first abolished the Provinces and consequently the "Provincial Basin Authorities" reorganised later in 2017 as "District Authorities" (see note 34) the second entrusted the Presidents of Regions as "Special Commissioners for the implementation of hydrogeological risk reduction projects" linking ordinary governmental key-actors to the reduction of risks (L. 56, 2014; L. 116, 2014). Other two innovative attempts to implement national-scale policies for risk reduction can be the setting-up of two "Mission Structures"[39] (see further) recently established by the Presidency of the Council of Ministers to address nature-related risks through a national-guided strategy: a "Mission Structure against hydrogeological instability and for the development of water infrastructures", shortly called "ItaliaSicura" ("Safe Italy") established in May 2014[40] and a Mission Structure for "developing, optimizing and integrating tools for the care and enhancement of the country's territory, urban areas and housing heritage" through the program "Casa Italia" ("Home Italy"). The Casa Italia program was launched by the Italian Government already on 25th August 2016[41], in the aftermath of the first quakes of that ruinous seismic sequence that will affect Central Italy until January 2017[42]. The homonymous Mission Structure was established in September 2016[43], composed of 17 experts and coordinated by Giovanni Azzone, Rector of the Polytechnic of Milan.

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[38] The so-called "Minimal Urban Structure" (SUM) is another notion gaining attention in the debate and legislation about risks and planning. While CLE strictly identifies strategic edifices and infrastructures, SUM stands for a "resilient" part of the urban structure able to remain functional during and after an emergency, ensuring the vital functions of a city also for sustaining the post-disaster recovery (Fabietti, 2013; Olivieri, 2013). The notion of SUM is present in Umbria's Regional Laws on Planning since 2005.

[39] For the implementation of particular tasks or programs, and the achievement of specific results, the President of the Council of Ministers establishes (by decree) temporary ad-hoc mission structures. Their temporary duration does not exceed that of the Government that established them.

[40] DPCM. 27 maggio (2014). Website: http://italiasicura.governo.it/site/home/dissesto.html

[41] Press Conference following the Meeting of the Council of Ministers held on 25th August 2016, available on Palazzo Chigi Youtube Chanel https://www.youtube.com/watch?v=G-XxXKV5eas

[42] Earthquakes hit firstly Amatrice area on 24th August 2016, Norcia and Macerata areas on 26th and 30th October, and northwest Abruzzo on 17th January 2017, involving 138 municipalities and causing about 330 direct and indirect victims.

[43] DPCM. 23 settembre (2016). Website: http://www.casaitalia.governo.it/it

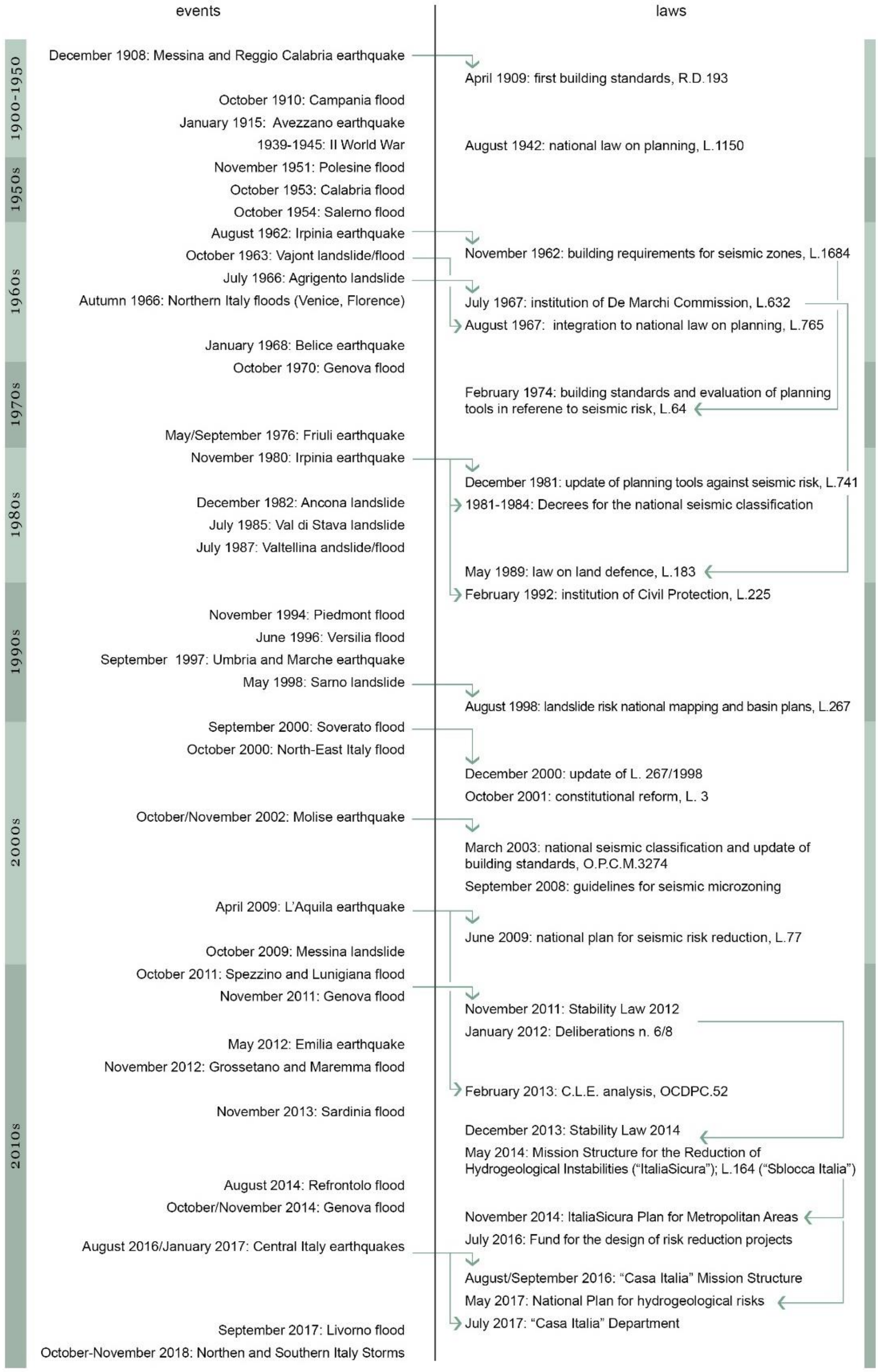

Figure 10. Main catastrophic events in Italy since the beginning of XX century, and the related regulatory framework influencing risk reduction and planning. Arrows indicate direct relations between events and promulgation of laws. Elaboration of the author.

Since the early 1970s, several reforms dedicated to administrative functions and local governance have taken place, and a crucial change in the system is recognizable in the "concurrent legislative powers" on territorial governance conferred to Regions by the reform of the Title V of the Constitution in 2001 (LC. 3, 2001). The 2001 reform brought to subdivisions and partial overlays of competences about planning, environmental protection and civil protection among different public bodies; therefore, urban planning is regulated also at the regional level according to laws, principles and practices specific of each Region[44]. Less recent regional laws and regulations on planning ignore issues about nature-driven risks, while laws defined or updated since the mid-2000s show a more advanced approach, closer to recent development in the international debate about risk mitigation[45]. In the majority of Italian Regions, basilar principles and notions about mitigation of natural risks have been metabolized from overriding national laws and debates, consequently achieving space in the regional laws for the government of the territory. Reduction of risk is openly stated as one of the focal objectives of territorial and urban planning only in some very recent cases, such as Umbria, Tuscany, Emilia-Romagna or Liguria regional laws[46] (Di Giovanni, 2016a).

ItaliaSicura and Casa Italia: national scale attempts of innovation (with an uncertain future?)

ItaliaSicura and Casa Italia[47] were both established as "Mission Structures" by the Presidency of the Council of Ministers led by Matteo Renzi[48], both encouraged by ruinous events that struck Italy: ItaliaSicura's path was fueled by floods between 2011 and 2014 while Casa Italia was openly related to the ruinous earthquake that struck Amatrice in August 2016.
In May 2014 the "Mission Structure for the Reduction of Hydrogeological Instabilities and the Development of Hydraulic Infrastructures" (ItaliaSicura) was launched with the following main goals (Decree of the President of the Council of Ministers DPCM. 27th May 2014, art. 2):

a. accelerating the *implementation* of interventions for reducing hydrogeological instability and developing water infrastructures;
b. ensuring the *coordination* of the interventions, by promoting the integration of the various phases of execution (planning, design and implementation, both for preventive interventions and post-event projects) and by supporting the various competent authorities (from central government to local authorities – especially Regional Presidents – including private agencies) in charge of projects, promoting a multilevel governance of interventions for risk reduction;

[44] An analysis of regional legislation about risk reduction was published by the author (Di Giovanni, 2016a).

[45] Startling assumptions can be found also in recent acts, such as in Veneto's regional resolution no. 1841/2007 about hydrogeological risk: "Increased human pressure on natural resources often *forces to plan urban development in areas with high geological risk, thus forcing to tackle risks ever higher* [...] It's very important to demonstrate that new planning forecasts will not aggravate *the existing level of flood risk, nor will compromise the possibility of reducing that level*" (italic added).

[46] Umbria: Regional Law no. 1/2015, artt. 1-2; Tuscany: Regional Law no. 65/2014, art. 1; Emilia-Romagna: Regional Law no. 24/2017, art. 1; Liguria: Regional Law no. 36/1997 as updated by Law no. 11/2015, art. 5.

[47] The author's research has been focused mainly on ItaliaSicura case, having the opportunity of performing interviews with chief officials and take part to seminars

[48] President from 2014 to 2016 (Partito Democratico, centre-left).

c. guaranteeing a correct and rational *use of available financial resources*, according to national and European funding lines.

The ambition of Casa Italia is broader (but less clear) than ItaliaSicura's, and stated as follows: to establish a long-term national policy to promote the country's "security" against risks of natural origin – divided into four major areas of intervention (data alignment; experimentation of innovative solutions for prevention; definition of financial needs and financing instruments; adoption of an information and training policy) – and a more effective and more efficient use of public resources – and to outline a new organizational structure which, when fully operational, will implement on the task of implementing such policy (Struttura di Missione Casa Italia, 2017, p. 17)[49].

Firstly, both projects moved from a reorganisation and normalization of available data and scientific knowledge about natural risks, for then defining guidelines, priorities and budget of intervention. The collection and harmonization of data represented a huge effort in both cases (as stated during ItaliaSicura seminars and confirmed by interviews with Officials of the Mission Structure). For instance, ItaliaSicura procedures are correlated to the preexisting Databases of the National Agency for Territorial Cohesion and to "Rendis" Platform[50] ("National Repository of Land Defense interventions") allowing (if correctly updated) an open access, geo-localized, monitoring of all the granted projects[51]. In fact, because of all funding applications must be managed through the Rendis Platform, the latter became a live-portray of the "national needs" for facing hydrogeological risks in terms of needed projects and finances. Istat released a National "Risk Dataset" elaborated for "Casa Italia" (see note 26) on August 2017, for "providing quality indexes and indicators, at the municipal level, which allow an overview of the risks of exposure to earthquakes, volcanic eruptions, landslides and floods, through the integration of data from various institutional sources, such as ISTAT, INGV, ISPRA, Ministry of Cultural Heritage"[52].
Secondly, chief function of both structures is to act as coordination boards of the multiple institutional actors engaged in the projects: ItaliaSicura has intensely collaborated on the one hand at national level with the Ministry for Environment Protection, the National Department of Civil Protection and the Agency for Territorial Cohesion and, on the other hand, on the local level with Regions' Presidents and Basins' Manager Authorities. The Mission Structure was involved in all the projects' phases, from the program design to their implementation. Resemblances can be found also with Casa Italia's goals: the first year of activity was dedicated to collecting and analysing data for sketching a "national vision" of the country's vulnerabilities, and identifying therefore pilot projects of risk reduction.
Thirdly, new specific funding opportunities were established, correlated to the Mission Structures. On the side of seismic risk, the 2017 Stability Law (L. 232, 2016) introduced a tax credit commonly called "SismaBonus" for promoting the renovation of the private building stock in earthquake-prone areas according to anti-seismic standards until December 2021.

[49] The first phase of Casa Italia project was devoted to "quality of living" meant essentially as the promotion of policies for enhancing the safety of residential buildings against natural hazards. The following phases should be dedicated to "environmental quality" (environment, landscape, energy) and to "infrastructural quality" (transports, digital infrastructures) of the country (Struttura di Missione Casa Italia, 2017).

[50] Managed by ISPRA for the Ministry for Environment Protection since 2005

[51] Information should be gathered also by the "National Dataset of Public Administrations"

[52] Presentation of the Risk Dataset from Istat webpage: https://www4.istat.it/it/mappa-rischi

The Bonus allows owners to be compensated of 50% to 85% of the restoration works costs in 5 years. More complex and wider is the funding strategy against hydrogeological risks. Specific funds (≈1,2 billion euros) for urgent interventions for reducing flood and landslide risk were granted between 2011 and 2014 – period in which several major floods involved all Italy causing 44 victims – by: 2012 and 2014 Budget Laws (or "Stability Laws") (L. 183, 2011; L. 147, 2013), two Deliberations of the Inter-ministerial Committee for Economic Planning no. 6 and no. 8 in 2012 (CIPE, 2012b, 2012a) and L. 164 (2014) (so-called "SbloccaItalia", "Unlock Italy")[53] (see Figure 10).

ItaliaSicura is the first national-scale program for reducing hydrogeological risks in Italy after the activities of De Marchi Commission (as described in the previous paragraph) and the official documents openly recall Law no. 183 as reference (Struttura di missione contro il dissesto idrogeologico e per lo sviluppo delle infrastrutture idriche, 2017, p. 16). SbloccaItalia Law (Law no. 164/2014, art. 7-9) imposed a "Program Agreement" signed by the Presidents of Regions (Commissioners for hydrogeological risk reduction by Law no. 116/2014) and by the Ministry for Environment Protection as instrument to allocate the public resources for financing hydrogeological risk mitigation interventions[54]. The same Law no. 164 allowed exceptions and acceleration measures for assigning and implementing extremely urgent public works necessary for hydrogeological and seismic risk prevention and protection of cultural heritage, and assigned 110 million euros (see note 53) for reducing hydrogeological risks in cities and metropolitan areas. A "Plan for Metropolitan Areas" followed indeed, launched in November 2014 counting 69 urgent interventions for 1,3 billion euros for Italian major cities; ItaliaSicura presented the complete "National Plan of public works for reducing hydrogeological risks"[55] in May 2017 (Struttura di missione contro il dissesto idrogeologico e per lo sviluppo delle infrastrutture idriche, 2017). Although its title, the National Plan more than a "plan" is an updated inventory of public works, indicating their costs, the level of design activities (from preliminary to executive projects) and the progress of construction sites: it better represents the "demand" and "state of the art" of necessary works for reducing flood and landslide risk in each Region (interviews with Officials of the Mission Structure). After one year of deliberations, a "Fund for the design of interventions against hydrogeological instability" (henceforth called "Design Fund") was finally established by decree in July 2016 (DPCM. 14 luglio, 2016), for fostering the design of public works and therefore make the projects quickly viable. The necessity of supporting design activities is openly stated in the norms[56] that led to the Decree in 2016, and confirmed directly by Officials of the Mission Structure: a large part of the funding requests presented by the Regions to ItaliaSicura for mitigation projects were based on "preliminary projects" or even just "feasibility studies", showing difficulties and delays in design activities for public works carried on by local administrations, above all in Southern Regions. The "Design Fund" was mainly thought to support local authorities in the definition of more advanced working plans/detailed designs and it's a rotative fund: when administrations receive the funds for the *execution* of works, they are required to give back the resources previously received for the *design* phase, in order to keep the "Design Fund" alive.

[53] Funds: 100 million euro by 2012 Stability Law (art. 33 c.8); 130 million euro by deliberation no. 6; 723,24 million euro by deliberation no. 8; 180 million euro by 2014 Stability Law (art. 1, c. 111); 110 million euro by Law no. 164 for Metropolitan Areas.

[54] The funding requests are managed through the Rendis platform aforementioned

[55] The "Plan for Metropolitan Areas" was considered a preliminary excerpt of the "National Plan"

[56] Such as in CIPE Deliberation no.32/2015 (CIPE, 2015), later on recalled by L. 221 (2015, art.55).

ItaliaSicura's funds are distributed according to national criteria and regional rankings defined by DPCM. 28 maggio (2015), compelling local authorities to be actively engaged in the preliminary and advanced design of public works (confirmed by interviews with Officials of the Mission Structure, of Liguria Region and of Genoa Municipality). Indeed, applications are evaluated according to: Design adequacy; Coherence with the purpose of hydrogeological risk mitigation; Coherence with the aim of integrating risk reduction activities with the improvement of the ecological status of watercourses and the protection of ecosystems and biodiversity. Priority and time schedule are defined along with the presence of already available projects and plans, people and assets at risk and frequency of the calamitous events, expected economic damage, post-opera residual risk and compensation measures, use of "green" or "nature-based" solutions[57] or green infrastructures. These criteria "balance" priorities on risk-related aspects and not non-territorial or administrative factors[58]. Closely associated with the aforementioned criteria for applications' assessments on the one hand, and the "Design Fund" goals on the other hand, ItaliaSicura started working on "Guidelines for the planning and design of interventions for hindering hydrogeological risks" already on February 2015. The Guidelines are an open document available online, drafted consulting national experts from multiple disciplines (ranging from geology to hydraulics, from biology to economics and structural engineering) and presented in each Region of Italy in more than 20 seminars between 2016 and 2017. Their purpose was to guide both public and private designers. The guidelines were constantly updated until the official version was released on September 2017 (Menduni, Brath, Iannarelli, & Zarra, 2017). The Guidelines have been reinforced by a Technical Report "Designing a Safe Italy", result of a brain-storm workshop held in Rome in December 2017 consulting more than 140 experts[59].
The Mission Structure Casa Italia has been transformed in a permanent Department of the Council of Ministers in 2017 (DPCM. 3 luglio, 2017) "for the development, optimization and integration of tools for the care and enhancement of the country's territory, urban areas and housing heritage, also addressing the safety-level and energy efficiency of the building stock". On the contrary, the Mission Structure ItaliaSicura was closed in July 2018 with the installation of the last Italian Government[60] and its functions have been transferred to the Ministry for Environment Protection (already partner of the Mission Structure).

3.3 DISCUSSING ITALY: MISSING ISSUES (MORE THAN MISSING KNOWLEDGE)

The urban scale: the uncertain balance between laws, data and planning

The fragility of the Italian territory is widely documented as shown by numerous academic studies, reports and data available (§Ch.3.1, and note 26) as well as by dedicated national and regional laws.

[57] For the notion and practices of Nature-Based Solution, see §Appendix.

[58] Part of the funds derive from Cohesion Funds that are mainly directed for Southern Italy as disadvantaged region: the Mission Structure has organized loans with the European Bank for financing interventions in North Italy

[59] The author participated to the workshop, Working Group 11 "The resilience of interventions".

[60] Decision announced in the Meeting of the Council of Ministers held on 2nd July 2018 and ratified by L. 97 (2018, art.2).

Nevertheless the robust knowledge about seismic and hydrogeological hazards developed in Italy, missing data and themes emerge, above all concerning urban systems. The availability of open-access data at local scale is only very recent[61] ,suggesting probably a weak attention dedicated to the issue of nature-driven risks in cities, even if 33% of Italian population live in municipalities with more than 50.000 inhabitants. In the same way, data are generally referred to hazards, and not to an evaluation of risk as the product of hazard, vulnerability and exposure. Looking at the normative frameworks about seismic and hydrogeological risk reduction, on the one hand the evaluation and mitigation of hazards have been progressively included in national and regional legislation and the role of planning activities in challenging these risks is recognized, but on the other hand these themes are not present yet in cases of obsolete (but still in force) regional laws on planning. In the meantime, high vulnerability of Italian territory and cities to nature-related hazards is demonstrated both by data analysed in Figure 9, both by the ruinous effects of earthquakes and recurrent floods and landslides summarized in Figure 10.

Some considerations about the widespread conditions of the territory related to the theme of risk can be sketched. As Casagli and Menoni recognized (among others), problems of inadequate implementation of the cited legislative frameworks – from a qualitative and/or quantitative point of view – can be a partial answer to Italian territorial fragility in its physical, social, economic and political aspects (Menoni, 2005, p. 161; Casagli, 2012); besides, if and how this wide legislative framework had efficiently influenced planning choices and awareness is questionable. The upgrades in the legislative frameworks have probably not triggered enough those necessary "anti-silos connections" between laws, actors involved, operational tools: indeed, risk reduction struggles to go beyond fragmented interpretations, regulations and plans[62], as topic in unstable balance between civil protection, planning and environmental protection[63]. Such normative objectives don't find an immediate enactment through urban planning because an effective reduction of risks through planning relies in a systemic ordinary strategy able to take into consideration the effects of territorial transformations on physical, functional, social and economic pillars of cities (Biondi, Fabietti, & Vanzi, 2011)[64]: this approach would maximise efforts and decrease costs, especially if implemented during times of peace. Instead, attempts to establish multidisciplinary and interinstitutional interconnections and cooperation emerge mostly only in post-disaster programs (Monaco & Monaco, 2012) when integrating technical and political choices is unreservedly recognised as the favoured strategy to reduce risks by all the communities affected by the disaster: experts, politicians, communities. The overlaps among different institutions and actors appointed in activities of risk reduction mirror a counterproductive fragmentation of responsibilities, roles and tools (Galderisi & Limongi, 2017). The known

[61] As discussed before, only last ISPRA Report no. 233 offers an open-access dataset from which extrapolating data about cities. Generally, data were accessible only at regional or provincial scale.

[62] For instance, the building regulation is dedicated mainly to reduce seismic risk and contains very few norms in terms of building resilience to hydrological processes. Many analyses, such as geological or seismic studies, were imposed more as formal acts than as actual boundary conditions for planning strategies for land use. Soil stability is not affected only by new urbanization but also by many other ordinary interventions in the cities; consequently, geological studies at the base of a reliable local planning cannot be only analytical, but should also guide new uses and projects.

[63] For example, the necessity of the spatial organization of civil protection and emergencies could be compulsorily included in land use decisions, to regulate consistently the design of planning instruments.

[64] Existing studies on the use of "Minimal Urban Structure" and "Limit Condition for Emergency" as categories for planning are examples (Fabietti, 2013; Olivieri, 2013). See note 38.

crisis of planning (Benevolo, 2012) and the pervasive phenomenon of illegal urban development[65] have to be added to these issues, as well as the weakness of control activities, the inadequate expenditure for activities dedicated to prevention and reduction of existing risks (Menoni, 2005; Amanti, 2014).

Rooted in reactive approaches

Nevertheless the available knowledge about risks affecting the Italian territory, the normative evolution summarised in Figure 10 confirms that a "reactive" approach for reducing nature-related risks has been traditionally predominant in Italian regulations (§Ch.1.1 and 1.3): feedback-driven, based on the necessary response needed after an event, and mainly described in literature as "resistant to changes". Regarding seismic risk, because of the impossibility of reducing the hazard, the reduction of vulnerability has been mainly delegated to an increase of structural resistance of buildings and infrastructures. On the contrary, regarding hydrogeological risks, the main approach has been the reduction of hazards intervening on hydrographic systems or on unstable areas. In both cases, the main strategy was delegated to engineering technologies, standards, regulations, almost considering exposure as "irreducible". As stated by an interviewee, a professor of Hydraulic Engineer: "the risk must be addressed also in terms of vulnerability intervening inside the urban fabric" and imaging new forms of coexistence with the risk and "even if waters go out from the stream beds and flood our country for a few hours, should not be a tragedy". The relation between urban planning and reduction of risk is mostly based on "assessments of compatibility" between proposals of future urban transformation and hydrogeological and seismic characteristics of the territory, assuming the knowledge of hazards and potential risks as a guide in designing planning. Without denying the fundamental role these methods for mitigating risks, poor references to strategic and systemic approaches represent recognized weaknesses (Cremonini & Galderisi, 2007).

Some Regions propose a different attitude. For instance, Umbria's regional law about planning and government of the territory (LR. Umbria 1, 2015) prescribes objectives and tools for the reduction of seismic urban vulnerability in town plans, integrating de facto prevention and planning activities[66]. In Emilia Romagna, according to the Annex A of Regional Law no. 20 (2000), the Structural Town Plan had to set out actions for eliminating or reducing the level of risk in existing settlements: in case of hydrogeological instability, hydraulic danger or avalanches, only recovery interventions on existing buildings are allowed, while "new constructions and land use changes that can augment the *exposure* to risk are prohibited" (Annex A-2). Law no.20 was reformulated in 2017 (LR. Emilia Romagna 24, 2017)[67]: the new law still pays close attention to the reduction of seismic and hydrogeological risks as goals of municipal planning. The "environmental services" provided by plans will also address nature-related risks and climate change (Art. 21) while urban regeneration programs can facilitate the renovation of buildings vulnerable to seismic risk (Art. 11). These examples can be read as steps towards pro-active approaches, that look at the reduction of risk as a combination of

[65] According to Legambiente and CRESME, between 1998 and 2003 the medium percentage of not legal buildings is about 30% of total heritage (Legambiente, 2008; as quoted by Destro, 2013).

[66] Umbria Region is considered exemplar for its attention to these issues after 1998 earthquake, for instance for its LR. no. 61/1998 and its previous regional law on planning (LR. no. 11/2005) (Di Salvo, Giuffrè, Pellegrino, & Pizzo, 2012).

[67] Annex A is still valid (Art. 29).

activities to reduce hazards, vulnerabilities and exposure, understanding cities as complex systems, not addressing single aspects[68]. There is no comprehensive dataset about the national expenditure for prevention activities compared to the costs incurred for repairing damages or the resources needed for full potential post-disaster recovery, but reliable data for depicting the national scenario are available:

- According to ANCE&CRESME report, between 1944 and 2012 Italy spent 240 billion euros for earthquake-related, landslide-related and flood-related events: between 1991 and 2011 about 10 billion euros of public funds were financed for the reduction of hydrogeological risks (ANCE & CRESME, 2012, pp. 141, 151).
- ItaliaSicura granted 1,3 billion euros with the Plan for Metropolitan Areas and 9,9 billion euros with the National Plan for interventions against hydrogeological risks but the estimated needs are 25,6 billion euros according to ItaliaSicura data.
- Regarding seismic risk reduction, Law no. 77/2009 funded 965 million euros ad-hoc to be used between 2010-2016 (Art. 11), managed by the National Department of Civil Protection that states: "It is only a minimum sum, perhaps less than 1% of the resources needed for the complete seismic adaptation of all public and private buildings, and of strategic infrastructural works. However, this operation will allow increasing the security of other public facilities [...] and will allow a decisive step forward in the growth of prevention culture"[69]

As affirmed before, the relationship between urban planning and activities of prevention and emergency management – mostly carried out by the Civil Protection – is still weak (see note 63), even if the last reform of the Civil Protection System (L. 100, 2012) imposes to plans involved in territorial government and protection to be coordinated with local emergency plans of civil protection (art. 3)[70,71]. Besides, how to reduce risks and intervene on existing urban fabrics exposed to existing risks (and commonly built in dissimilarity to regulations) represents probably the most delicate and hard aspects of the theme. As every process of urban transformation in built contexts, the reduction of risks needs to be carried out through cross-sectorial activities (adaptation of housing stocks and infrastructures, urban retrofitting aimed at the recovery of open spaces, building redundant paths, changing uses and locations) confronting with inherited uses, regulations, historical values and social significances of the city (Lazzari, 1988; Fera, 1991; Casagli, 2012; Monaco & Monaco, 2012). Genoa and L'Aquila cases (§Ch.4, Ch.5) highlight these last points.

From chronical delays towards empowering proactive approaches

ItaliaSicura official reports highlight an evident delay in the ordinary design of public works about hydrogeological risk reduction in Italy carried on by local administrations: more than the 70% of the works listed in the National Plan are not even designed yet (Struttura di

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[68] Proactive approaches are feedforward-driven, based on prevention, anticipation and adaptation (§Ch. 1 and Godschalk, 2003; R. J. T. Klein, Nichollsb, & Thomallaa, 2003; Hollnagel et al., 2006).

[69] http://www.protezionecivile.gov.it/jcms/it/piano_nazionale_art_11.wp

[70] In this sense, the introduction of the analysis of "Limit Condition for Emergency" mentioned previously can contribute to a deeper relation between planning, reduction of risk and civil protection activities

[71] For instance, Tuscany and Calabria's regional laws on planning confer to town plans the contents and efficacy of emergency plans too; consequently, every update due to emergencies or to ruinous events should constitute a direct variation of the town plans.

missione contro il dissesto idrogeologico e per lo sviluppo delle infrastrutture idriche, 2017, pp. 18, 530). This problem has been illustrated also in the Parliament in 2017 (Commissione VIII Ambiente Territorio e Lavori Pubblici, 2017). According to the author, such absence increases the risk because hinders prevention, and affects the recovery paths that cannot rely on pre-existing projects and plans. The same lack of "ordinary design of public works" for risk reduction and infrastructural maintenance was confirmed by several interviews, both by Municipal Official and by ItaliaSicura Officials: "the absence of projects is true: we come from years in which there was no money for realising public works, so why to design them in the first place?" (interview with a Professor of Hydraulics, CIMA Foundation)[72]. In fact, the principles of "good administration" in the Italian Constitution (art. 81, 97) and in the Code of Local Administration (DLgs. 267, 2000) require that "acts which produce an expenditure are adopted only if the needed full budget is available": consequently, the expenditures for public works were not carried out if finances for the implementation of the works weren't available). In fact, "a direct implementation of ItaliaSicura 2014 Plan for Metropolitan Areas was *utopic*" even according to the Officials of the Mission Structure because of the lack of available projects. The weakness of local administrations in designing and managing these works – and the weakness of the coordination role of the State after 1998 Bassanini reform (DLgs. 112, 1998) – has been often underlined during technical seminars and directly by interviewees who, in the meantime, express the necessity of making local authorities more robust and more involved, through paths of (mutual) collaboration between local and central technical bodies. The procedure for funds assignments established by ItaliaSicura (DPCM. 28 maggio, 2015) represents an attempt towards a proactive prevention strategy for the reduction of hydrogeological risks: on the one hand, it pushes the active role of local administration making them even more responsible of the design of works; on the other hands, they clearly expand the role of non-structural measures in reducing risks. As stated by Torsello and Leoni, the set of criteria established by ItaliaSicura "represented a decisive change of perspective, avoiding that choices could be contaminated by elements not related to technical criteria (primarily, political) and at the same time focusing on risk-related aspects: resources were primarily given to projects able to better guarantee the safety of citizens and assets exposed to risk" (Torsello & Leoni, 2018, p. 110). The SismaBonus campaign somehow tries a similar approach for seismic risks, trying to promote a preventive large-scale program of reducing seismic vulnerabilities at the building scale.
The table of contents of the "Guidelines for the planning and design of interventions for hindering hydrogeological risks" follows (Menduni et al., 2017):

1. *Risk assessment and management criteria*
2. *Comparative evaluation of different technical options through benefits/costs analyses*
3. *Coherence of the intervention with current planning*
4. *Systemic analysis: spatial aspects with particular attention dedicated to induced phenomena and to the non-aggravation of risks at basin scale*
5. *Systemic analysis: temporal aspects and estimation of intervention's life-cycle*
6. *Specific hydrological assessments*
7. *Specific geological and geotechnical assessments*

[72] The new Code of Public Tenders (DL. no. 50/2016) seems to put new emphasis on the design phases (Struttura di missione contro il dissesto idrogeologico e per lo sviluppo delle infrastrutture idriche, 2017, p. 22)

8. *Effects of the intervention on fluvial, coastal and slopes morphodynamics*
9. *Effects of the intervention on river and coastal ecosystems and on water quality*
10. *Social and economic effects of the intervention*
11. *Resilience of the intervention, also in the comparisons to climate change scenarios*
12. *Georeferenced classification of interventions' fundamental data*

These titles represent somehow an expressive summary of the points discussed in this chapter; the twelve chapters of this Guideline – meant to guide designers of flood risk interventions – highlight quite meaningfully the weakness of the Italian approach to reduce risks.

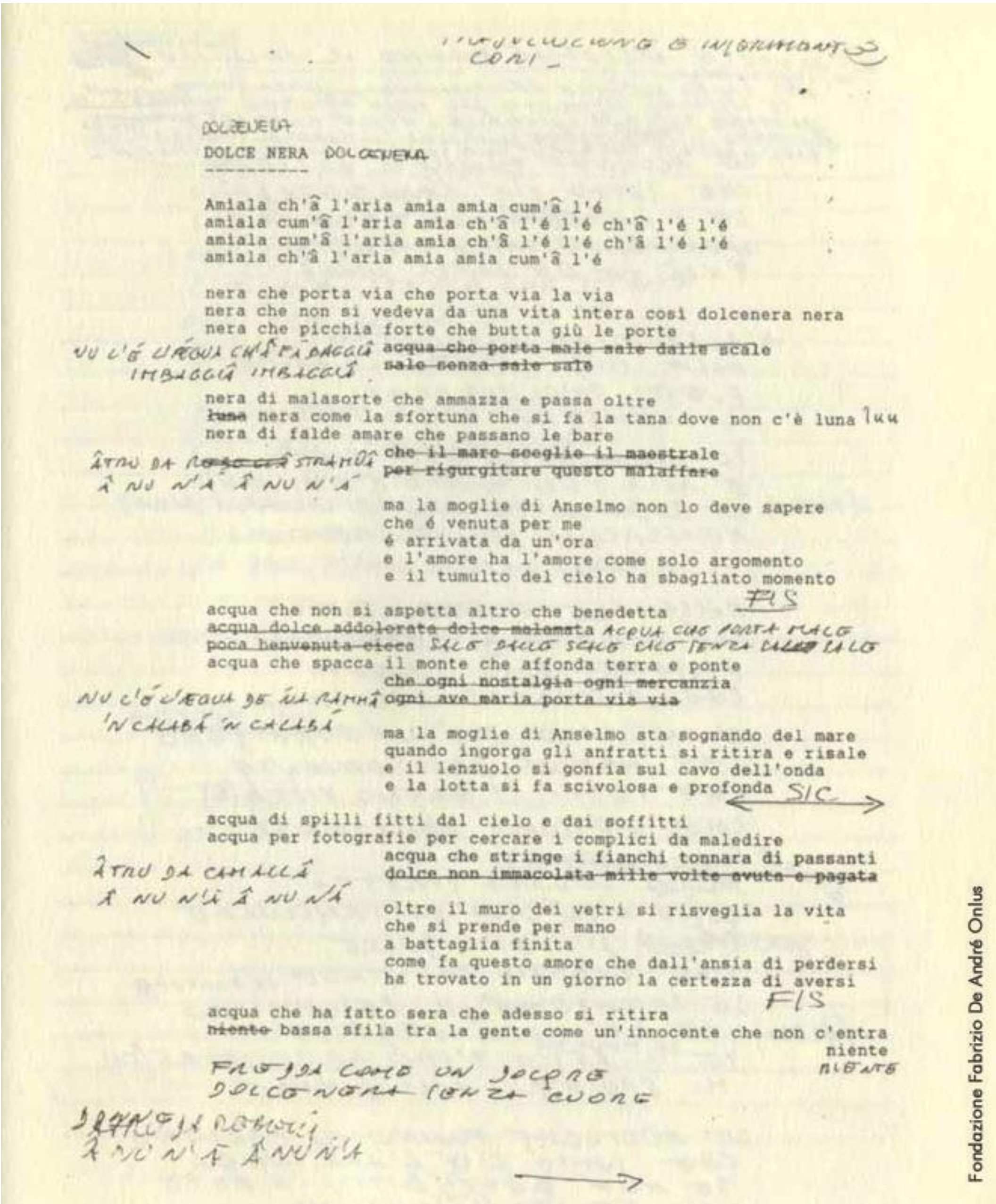
The investigations carried on in this chapter portray the risks affecting the Italian territory and the regulations and policies depicted at a national level for addressing them in the field of urban planning and governance (§Ch.1.3) confirming the role of disasters in triggering enlarged scientific debates and legislation updates (as introduced in the theoretical framework, §Ch.2.1). The national scenario guided the investigation at city level, focused on the cases of Genoa (§Ch.4) and L'Aquila (§Ch.5) – cities characterized by very high nature-related risks and struck by recent disasters – with the purpose of examining in depth policies, regulations and plans implemented for recovering from catastrophic events and reducing risks, exploring bottlenecks and efficacy. Strong relations link the national policies and regulations and case-specific urban strategies, confirming also the national paths, but also distinctive context-dependent outcomes emerge.

Interviews and Seminars – Chapter 3

Geologist, Technical Official of ItaliaSicura Mission Structure		National Civil Protection offices, Rome - 27th June 2017
Statistical Analyst, Technical Official of ItaliaSicura Mission Structure		Presidency of the Council of Ministers offices, Rome - 11th July 2017
Engineer, Technical Official of ItaliaSicura Mission Structure		Presidency of the Council of Ministers offices, Rome - 12th July 2017
Lawyer, Official of ItaliaSicura Mission Structure		Presidency of the Council of Ministers offices, Rome - 18th January 2018
Technical Seminars:		
Sapienza University & Rome Order of Architects	Preventing urban seismic risk: A multidisciplinary approach; Prevention of seismic risk and urban planning: technical insights, tools, regulatory references and operational applications	Sapienza Faculty of Architecture, Rome - 17/18th November 2016
ItaliaSicura & Rome Order of Architects	Resilience and security for territories and cities. Design for seismic and hydrogeological risk prevention	Order of Architects, Rome - 1st March 2017
ItaliaSicura & National Council of Research	The culture to be saved: cultural heritage and natural risks. The Map and the National Action Plan	National Council of Research, Rome - 28th June 2017
ItaliaSicura & Rome Order of Architects	Planning for environmental resilience and prevention for the future of cities	Order of Architects, Rome - 20th July 2017
ItaliaSicura	Designing a Safe Italy. 12 tables, 1 shared guide against hydrogeological instability	Rome - 13th December 2017

CHAPTER 4

Genoa and the Flood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nera di falde amare che passano le bare
~~che il mare sceglie il maestrale~~
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é arrivata da un'ora
e l'amore ha l'amore come solo argomento
e il tumulto del cielo ha sbagliato momento

acqua che non si aspetta altro che benedetta
~~acqua dolce addolorata dolce malamata~~
~~poca benvenuta cieca~~
acqua che spacca il monte che affonda terra e ponte
~~che ogni nostalgia ogni mercanzia~~
ogni ave maria porta via via

ma la moglie di Anselmo sta sognando del mare
quando ingorga gli anfratti si ritira e risale
e il lenzuolo si gonfia sul cavo dell'onda
e la lotta si fa scivolosa e profonda

acqua di spilli fitti dal cielo e dai soffitti
acqua per fotografie per cercare i complici da maledire
acqua che stringe i fianchi tonnara di passanti
~~dolce non immacolata mille volte avuta e pagata~~

oltre il muro dei vetri si risveglia la vita
che si prende per mano
a battaglia finita
come fa questo amore che dall'ansia di perdersi
ha trovato in un giorno la certezza di aversi

acqua che ha fatto sera che adesso si ritira
~~niente~~ bassa sfila tra la gente come un'innocente che non c'entra
niente

Figure 11. Text of "Dolcenera", Fabrizio De André's song narrating the 1970 Genoa flood. Courtesy of Fondazione Fabrizio De André Onlus (De Andrè F., Fossati I. "Dolcenera". On *Anime Salve*, BGM-Ricordi, 1996).

4.1 EVER AT RISK

Genoa is a city of about 583.000 inhabitants[73], capital of Liguria Region in North-Western Italy: it is affected by severe hydrogeological instabilities since centuries and represents an emblematic case of recurrent floods in urban contexts due to a particularly complex interplay of natural and anthropogenic processes[74]. An ancient nucleus of Genoa was located along the Bisagno stream, whose sea mouth operated as a prehistoric river port (Rosso, 2014, p. 23); the city grew around its maritime harbour, involved in major Mediterranean trades already in XII century.

At the beginning of XVII century the urban area was protected by a monumental wall system built along the hill ridges surrounding the harbour: the so-called "New Walls" were 20 km long and embraced the port and the core of the city up to the Peralto Mount[75]. Figure 12 offers a clear sight of the morphology of the city and its spatial relation with Polcevera and Bisagno river valleys.

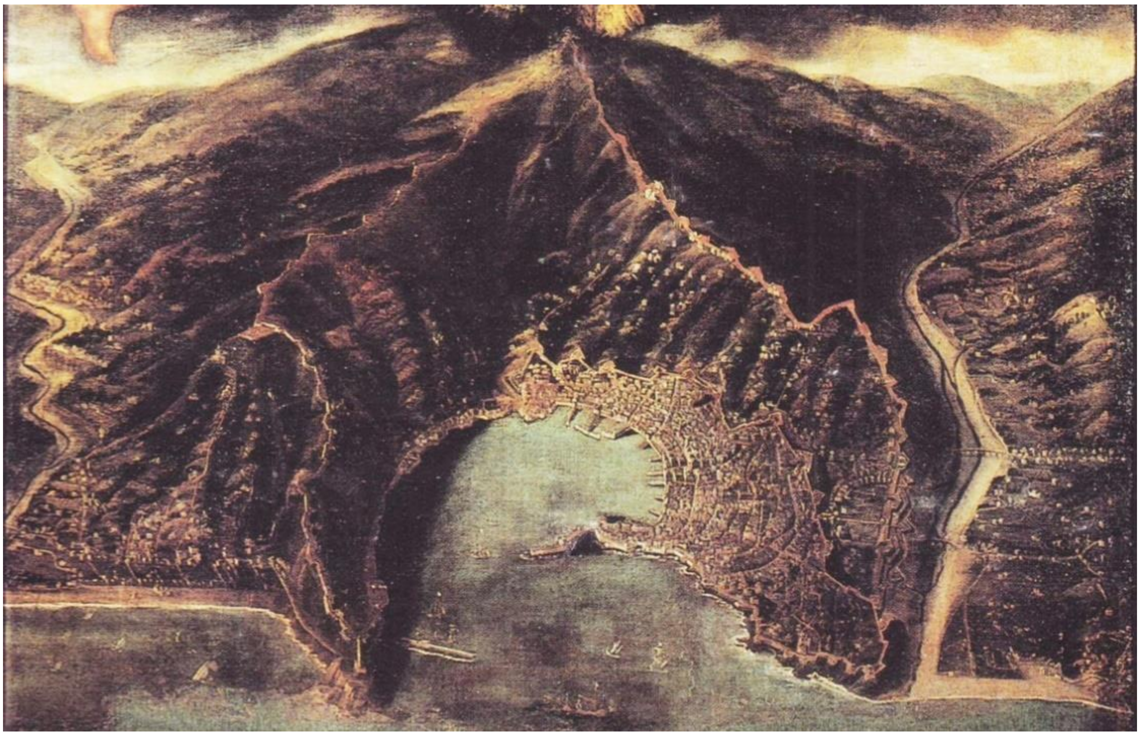

Figure 12. Detail of *"La Madonna regina di Genova"* by Fiasella (1638), in San Giorgio dei Genovesi Church (Palermo). Two river valleys define the surroundings: Polcevera on the left, Bisagno on the right[76].

The city grew up along the coast because constricted by Liguria's peculiar geomorphology: the territory is almost completely mountainous and hilly, with only modest coastal plains because mountains descend precipitously to the sea. Constrained between the shore line and the Apennines, Genoa is a "no-land-city", without a territory to expand on (Fuselli, 1955, p. 155; Bobbio, 2008, p. 84): since the XIX century the urban development – for allocating residential

[73] Sixth municipality in Italy for population size (ISTAT 2017, http://demo.istat.it/pop2017/index.html)

[74] For a list of major events in Genoa's flood hystory, see Scolobig (2017, p. 9).

[75] Long segments of the walls still exist.

[76] Picture from: http://www.giuntafilippo.it/genova-2/1600-1699-2/

and industrial functions, since manufacturing has been a pillar of Genoa's economy[77] – was assured by massive soil exploitation. Adjacent villages were merged in Genoa's system in a "urban continuum" along the narrow shoreline first, and following the main river floodplains later, especially along the Bisagno and Polcevera streams (Brandolini & Sbardella, 2001, p. 199). Plains and valleys were already all urbanized between World War I and II: the urban expansion progressed climbing the narrow and steep river valleys that converge towards the coastline, slowing down only around 1970s. The result is a hyper-dense urban fabric, with very expensive land and construction costs (Bobbio, 2008, p. 86): the development of the city was able to even reclaim land from the sea. Currently, the municipality borders encompass a hilly narrow territory: about 30 km long along the east-west direction, and less than 10 km along the north-south direction with an elevation going from 0 to ≈1.180 m.a.s.l. Genoa is crossed by dozens of streams and creeks that shape ten main river catchments (Figure 13, Figure 14), Polcevera's and Bisagno's being the principal ones. The municipality current population density is ≈2.430 inhabitants/sq.km., that rises to ≈8.830 inhabitants/sq. km. if referred to the only urbanized surfaces (28%) of the municipality[78].

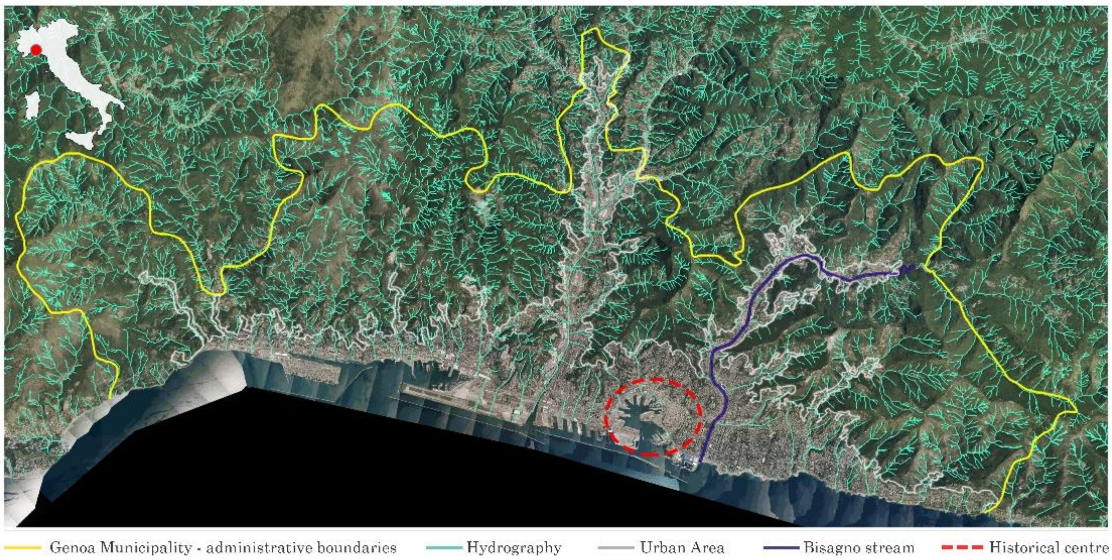

Figure 13. Genoa: municipal administrative boundaries, identification of the urban area, hydrography (Bisagno stream highlighted). Elaboration of the author (Source: Liguria Region Geoportal[79]; background: AGEA 2016 orthophotos).

[77] Manufacturing is still a fundamental economic sector for number of employees in the city, even if declining (Bobbio, 2012; Comune di Genova, 2017, p. 30).

[78] Elaboration of the author. Data from Comune di Genova (2011a, p. 248).

[79] http://geoportale.regione.liguria.it/geoportal/catalog/main/home.page

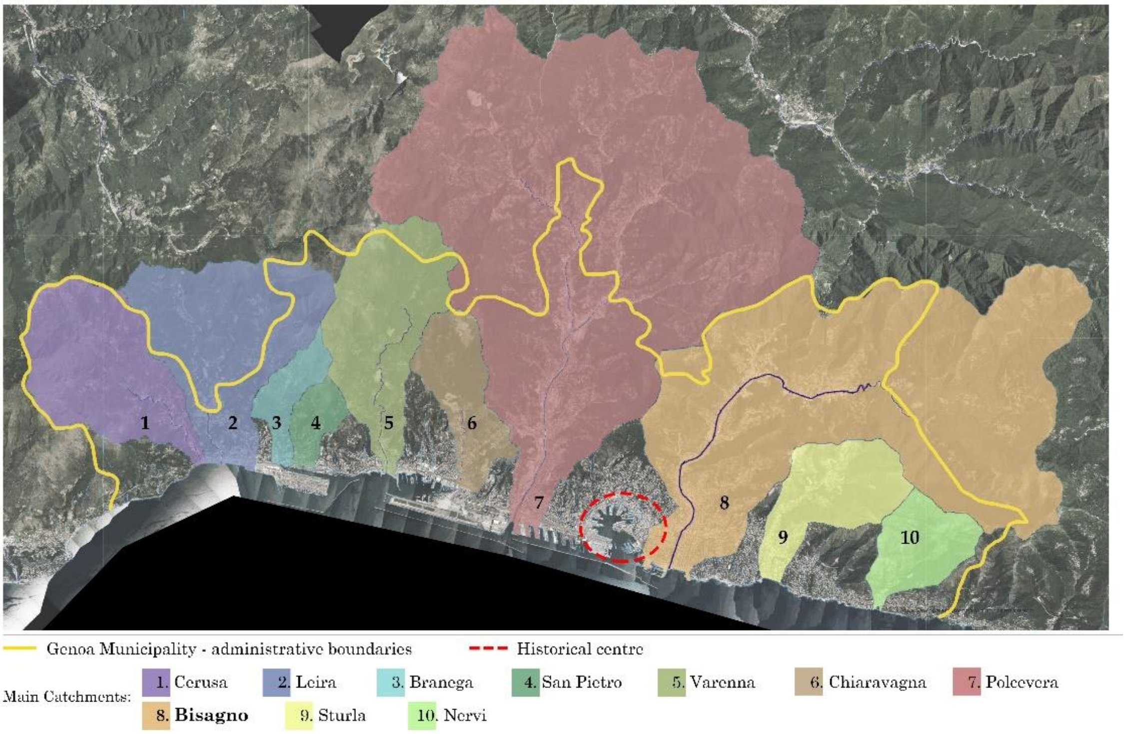

Figure 14. Genoa main catchments. Elaboration of the author (Source: Liguria Region Geoportal; background: AGEA 2016 orthophotos) (Brandolini, Cevasco, Firpo, Robbiano, & Sacchini, 2012, p. 948).

The railways run from east to west, parallel to the shoreline, and intersected all Liguria's rivers, often with too low bridges; the coast has been deeply transformed in recent decades (as shown in Figure 15) by the enlargement of the port towards Voltri-Prà, the creation of the airport and the establishment of industrial sites in Cornigliano, the new docks in Sampierdarena, and the realisation of the Fair area (Capponi & Crispini, 2008, pp. 124-125). Genoa is still among the major Italian multi-service ports for cargo transport, shipbuilding industry, cruise and ferry passengers (Associazione Porti Italiani, 2018).

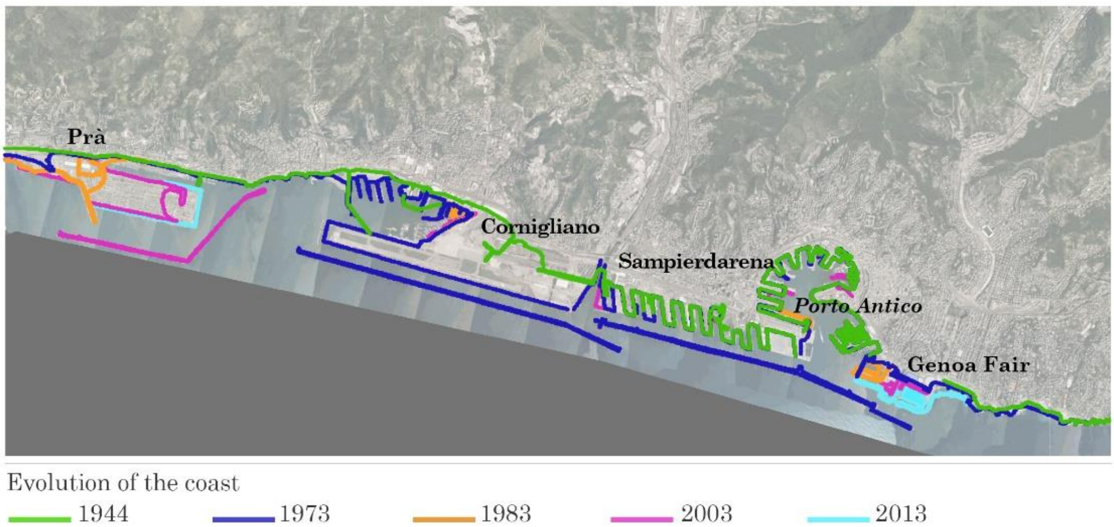

Figure 15. Transformation of Genoa's coast. Elaboration of the author (Source: Liguria Region Geoportal; background: AGEA 2016 orthophotos)

Large land-use transformations occurred constantly for facilitating the expansion and management of ancient and modern urban fabrics, and strongly affected local drainage systems, altering the local streams both along their courses – especially when crossing the urban fabrics – and in the mouth areas (among the others: Brandolini, Ramella, & Terranova, 1992; Tizzoni, 2000; Bobbio, 2008; Brandolini et al., 2012; Faccini et al., 2018): water flows have been abused, rectified, forced through artificial canalizations, often with over-reduced run-off sections below street coverages (Figure 20). More than 200 km of rivers in Genoa have been "artificialized"[80], equal to the 23% of the entire river system length in Genoa territory (Brandolini & Sbardella, 2001, p. 215).
Genoa's urban development has exacerbated the exposure of the city to hydrogeological hazards, the latter already high because of both the complex local geomorphology, and the peculiar climatic characteristic of the Genoa gulf. In fact, river catchments in Liguria are small and precipitous, and have a very short hydrological response time that is exacerbated in conditions of intense rainfall. Moreover, from a meteorological point of view, rainfall regimes are affected by the proximity of the Mediterranean Sea to the mountain chains which perform a barrier effect between southern and northern air masses. The Gulf of Genoa is characterized by a typical circulation named "Genoa Low" or "Ligurian depression": a cyclone is formed over the Gulf, south of the Alps, and generally remains stationary. In case of arrival of Atlantic (cold) perturbations behind the Alps "conditions of sharp thermodynamic contrast between hot humid Mediterranean air masses and cold air masses of continental origin are created" (Faccini et al., 2015, p. 2636): the cold air masses behind Ligurian Alps are redirected towards the Gulf by the Genoa Low, moving at modest altitudes (between 450 and 600 m.a.s.l.), while "southern wet and warm air masses from the Mediterranean flow over these colder air masses. This typical circulation is responsible for the large amounts of rainfall distributed over the region. […] These convective systems have recently affected different locations over the Ligurian Gulf (Faccini et al., 2012), causing flash floods arising from rainfall intensities of over 500 mm/6 h or 180 mm/1 h" (Faccini et al., 2015, pp. 2636-2637). Brandolini and colleagues show that a decreasing trend in rainy days is associated with stationary trends in precipitation values, indicating an increased precipitation rate in the area of Genoa between 1830 and 2006 (Brandolini et al., 2012, pp. 947-948).
These characteristics determine two primary consequences: 1. Liguria is a very rainy region, especially in autumn, with very short runoffs times; 2. "Accurate weather forecasts is vital" for reducing risk and optimizing emergency response (Brandolini et al., 2012, p. 944). Flood events that struck the city for centuries are the mirror of the aforementioned huge land consumption, worsened by the ongoing climate change: "the distribution of the urban settlements on the coast or along the river mouths – locations with the maximum level of criticality in case of high river water levels – exacerbates flood damages" (Brandolini & Sbardella, 2001, p. 201). In fact, the increased urban density in hazardous areas amplifies local instabilities and vulnerabilities, and consequently the local flood risk and the frequency and expensiveness of disasters: several cases of residential or industrial constructions built dangerously alongside, upon or "inside" stream beds (Figure 16 to Figure 18-Figure 19. Images of Chiaravagna 2010 flood from the building in via Giotto no. 15.) are recorded in the city, like former ILVA or PIAGGIO warehouses along the Chiaravagna river in Sestri Ponente

[80] 28 km are channelled, 70km are embanked, 115 km are covered.

area – that experienced a severe flood in 2010 – or now decommissioned ITALSIDER industrial area on the Polcevera's mouth (Bobbio, 2012, p. 31).

Figure 16. Building in via Giotto no. 15 inside Chiaravagna riverbed[81]. Picture from Google Street View, May 2012

Figure 17. Building in via Giotto no. 15 during 2010 flood[82]

Figure 18-Figure 19. Images of Chiaravagna 2010 flood from the building in via Giotto no. 15[83]. The building was demolished in January 2013.

Furthermore, the abandonment of traditional forestry and agricultural practices on terraced slopes "triggering the decay of forests and slopes and therefore exacerbating landslides and the presence of debris in the streams beds" (interview with a professor of urban planning from Genoa University) contributes in augmenting local hazards. In fact, all the municipality is involved by severe hydrogeological criticalities: ≈29.770 inhabitants live in areas at high/very high landslide risk (P3-P4) and ≈49.160 inhabitants live in areas at high flood risk (P2) according to Istat Dataset[84] (§Ch.3.1), indicating that the 13,5% of Genoa's total population is exposed to high hydrogeological risks. The urbanized surfaces especially reveal high risks: the urban area is directly and extensively affected by medium and high flood hazard, and it's enclosed by landslides (even if manly dormant), as shown in Figure 21 and Figure 22. As sharply highlighted during an interview with a researcher in hydraulic engineer from CIMA Foundation, urban flood risk is mostly due to urban morphology, urban fabrics, planning choices: climate change and the scarce maintenance of woods play a role in urban floods, but are not the root causes of risk, because since the beginning of XX century urban water courses have been constricted and "mistreated" in all Mediterranean coastal cities.

[81] In early '50s the construction of a cinema was legally approved in the exact same place inside Chiaravagna riverbed. Soon the project changed, giving birth to a four-floors housing building. Already in late '60s the Public Works Offices declared the building "non adequate from a hydraulic point of view"; legal actions between the several public institutions involved and the inhabitants started already at the end of '70s (Imarisio, 2014, and confirmed by an interview at Liguria Land Defence Department).

[82] Screenshot from YouTube video: https://www.youtube.com/watch?v=6tvC04Y5uXQ

[83] Screenshots from YouTube video: https://www.youtube.com/watch?v=tDX1ine4b1E

[84] Istat data at city level are available at: https://www4.istat.it/it/mappa-rischi/indicatori

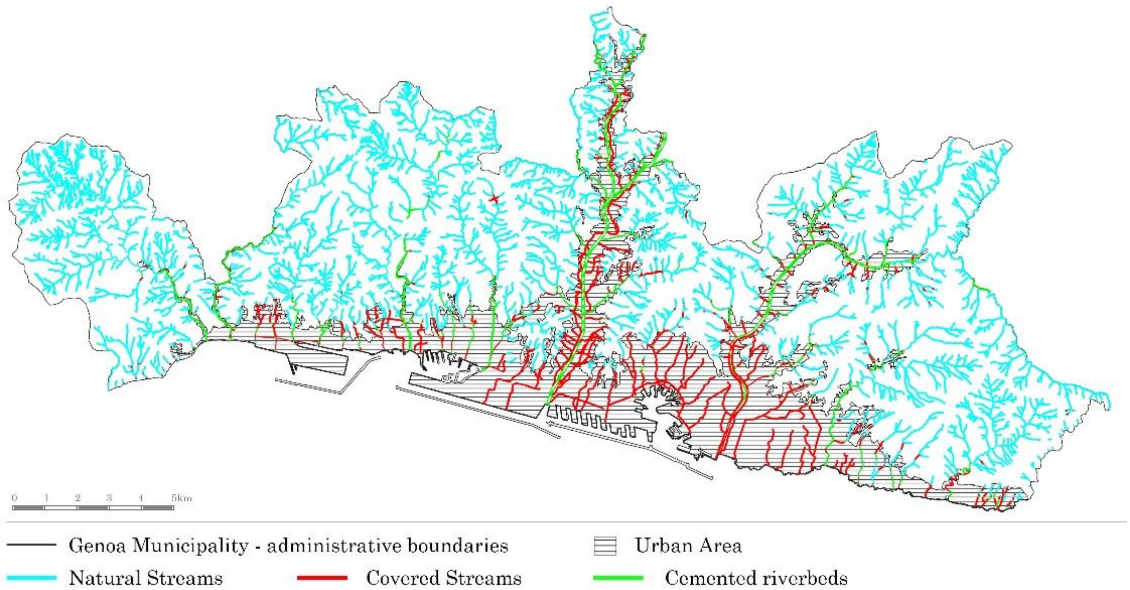

Figure 20. Genoa hydrography: the artificialization of water.
Elaboration of the author (Source: Genoa Geoportal[85])

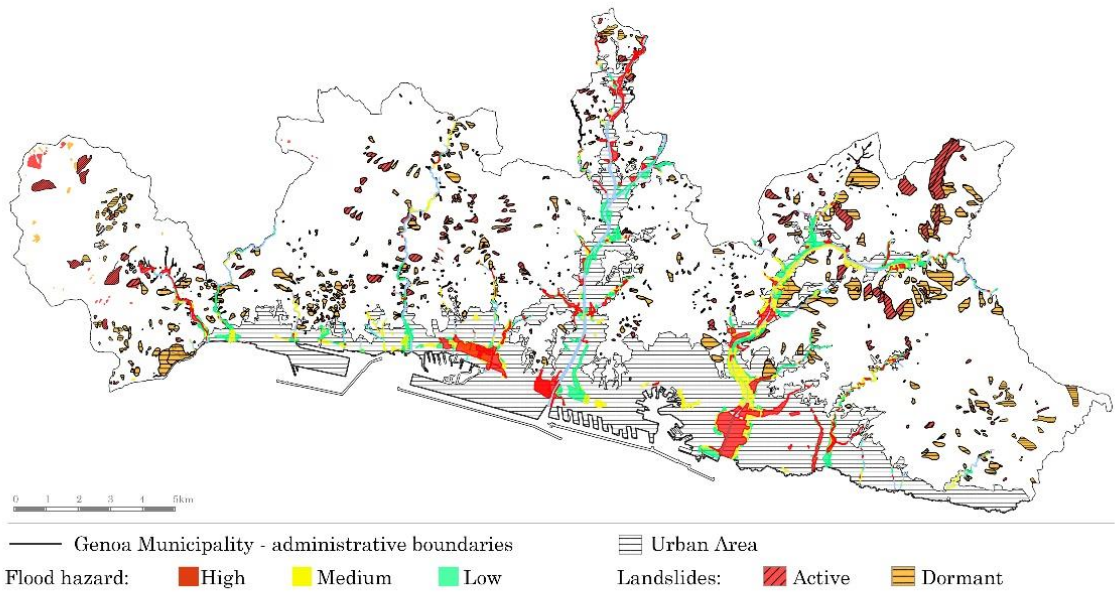

Figure 21. Mapping main flood hazard and landslides in Genoa. Elaboration of the author (Source: Genoa Geoportal)

[85] http://geoportale.comune.genova.it/

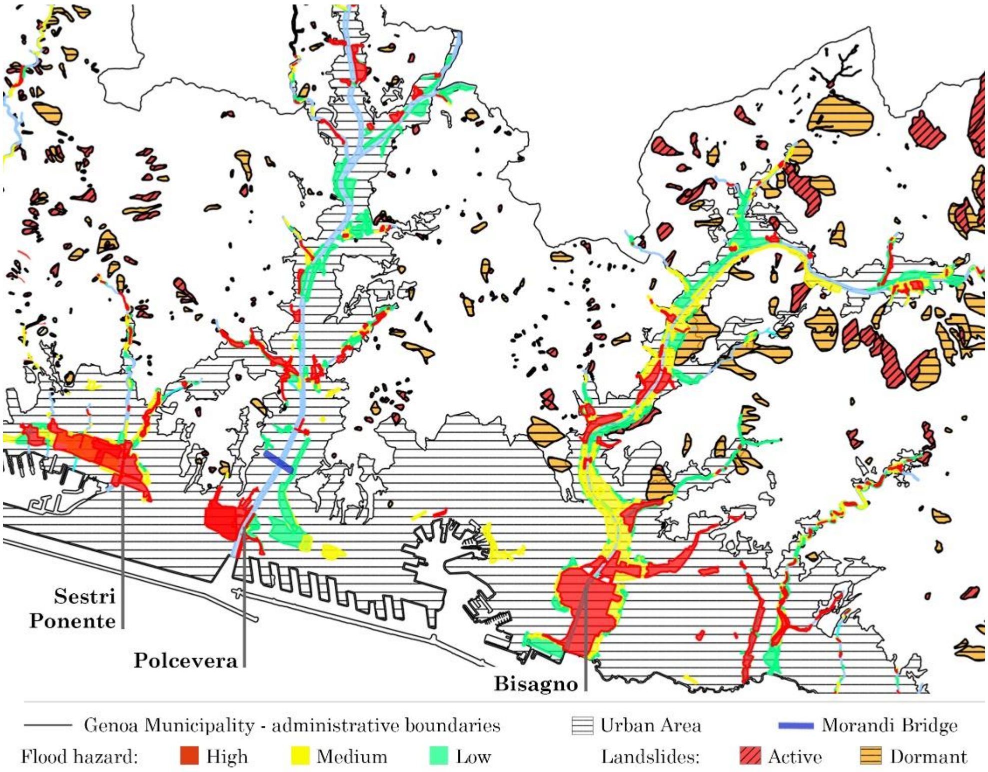

Figure 22. Detail of Figure 21, highlighting the flood and landslide hazards in the critical industrial site of Sestri Ponente, and along Polcevera[86] and Bisagno river valleys.

Genoa experienced recurrent severe floods and landslides since the beginning of XV century (Brandolini et al., 2012; Rosso, 2014, pp. 25-26): in recent times two main floods stroke the city on 7th-8th October 1970 (44 victims) and on 4th November 2011 (6 victims); other ruinous floods happened in September 1992, September 1993, October 2010 and October 2014, for a total of 12 victims. The rainfall in October 1970 was the most extreme event ever registered in Genoa, according to the literature. Since 1992, the total damage losses have been evaluated as € 1,426 billion (Faccini et al., 2015, p. 2637).

The flood risk governance

In 1989 National Law no. 183 (§Ch.3.2) introduced the "River Basin Authorities" *(Autorità di Bacino)* as competent institutional bodies to manage river basins from national to local scale (L. 183, 1989). In enactment also of the National Law L. 267 (1998), Liguria Region started defining regional and provincial competences involved in all the cognitive processes needed for defining basin master planning and intervention phases (LR. Liguria 9, 1993; LR. Liguria 18, 1999; LR. Liguria 58, 2009; LR. Liguria 15, 2015), as sketched in Table 5. The Liguria

86 The motorway "Polcevera Viaduct", better known as "Morandi Bridge", crossed Polcevera river about 1,4 km upstream the areas at high flood hazard. The bridge collapsed on the riverbed on 14th August 2018; already the following day, the director of the National Civil Protection Angelo Borrelli affirmed that the removal of the ruins was an urgent priority for reducing flood risk in view of the upcoming fall rainy season (Press interview available at: https://video.repubblica.it/edizione/genova/genova-crollo-ponte-morandi-protezione-civile-via-al-piu-presto-le-macerie-dal-letto-del-polcevera/312484/313116).

Region set general criteria and guidelines for the definition of the River Basin Management Plans (*Piani di Bacino*), being responsible also of their interregional and interinstitutional coordination; the River Basin Authorities act both at regional and provincial level through technical committees at provincial level: until 2015 Provinces have been in charge of the design and approval of Basin Management Plans, of the general management and maintenance of principal rivers, and of the definition of all hydraulic works for controlling flood risk. Municipalities were responsible for the design, implementation and maintenance of projects and public works for land defence, while "Mountain communities"[87] (*Comunità Montane*) were also involved in the definition of land protection from hydrogeological instabilities in their territories. Provinces have clearly represented the main actors in flood risk reduction in Liguria territory.

Authority	**Responsibilities**
Liguria Region and Regional Basin Authority	Criteria and guidelines for River Basin Plans; interregional and interinstitutional coordination
Provinces (Genoa, Imperia, La Spezia, Savona) and Provincial Basin Authority Committees	Design and approval of Basin Management Plans; maintenance and management of principal rivers; definition of all hydraulic works for controlling flood risk
Municipalities	Design, implementation and maintenance of local projects and public works

Table 5. Main actors involved in flood and landslide risk management in Liguria Region. Elaboration of the author.

The province of Genoa was the first in Italy to approve a regional Basin Management Plan for hydrogeological instabilities, namely the Basin Plan for the Chiaravagna Basin between 1997 and 1998, followed by the plans for the Varenna (1998-1999) and the Bisagno streams (2000-2002). At municipal level, Genoa's current Town Plan disciplines the transformations of the territory also from a hydrogeological, landscape and environmental point of view. It was adopted in December 2011 and approved in December 2015, and the General Reports states "land protection and environmental quality" as one of the principal goals of the plan[88] (Comune di Genova, 2011b, 2018b). This goal is defined by specific targets for addressing hydrogeological instabilities and hydraulic hazards – mainly through limitation, prescriptions and incentives to be applied in urban transformations – implementing firstly the Basin Plans' indications. Environmental goals are embedded as "environmental performances" and regulatory standards for the so-called "Transformation Districts", zones were wider and more complex transformations of the existing urban fabrics are planned (Comune di Genova, 2018a).

[87] Union of mountain municipalities with functions of promotion of mountain areas. Born in 1971, these authorities have been abolished or reduced in many Italian regions since early 2000s.

[88] Together with "Economic and infrastructural development" and "Urban spatial organization and relaunch of the image of the city"

4.2 BISAGNO AND THE FLOODS

The urban risk in Bisagno valley

Bisagno stream flows from Scoffera Hill (675 m.a.s.l., ≈20 km north-east of Genoa city), crosses the eastern part of the city, and flows into the sea in the Foce[89] neighbourhood, next to Genoa Trade Fair and Exhibition Centre. The stream is ≈25 km long and its catchment covers an area of about 95 sq.km., 53 sq. km. in the municipal district[90] (Brandolini et al., 2012, p. 945; Autorità di Bacino Regionale, 2017b, p. 9). As shown in Figure 20 and in detail in Figure 23, the Bisagno stream has been completely artificialized[91] both cementing its riverbed and banks, and covering its course for long segments (Figure 24-Figure 28). similar conditions characterize also the Fereggiano stream, last Bisagno's tributary on the left. It crosses a very densely urbanized area, and flows under a coverage for its last 600m (Figure 33-Figure 36) before entering in Bisagno riverbed; its section is proved to be insufficient even for the 50 years return period discharge (Silvestro et al., 2012, p. 2747; Autorità di Bacino Regionale, 2017b). According to Bisagno Basin Management Plan, very high flood risk affects the urban areas surrounding Bisagno's course, as shown in Figure 37: both Bisagno and Fereggiano flood recurrently (Figure 29-Figure 32), and caused among the worst damages in the 2000 floods (Rosso, 2014). Severe geological risk involves shorter parts of the river system, as shown in Figure 38.

[89] Literally "river mouth" in Italian.

[90] Bisagno catchment is the largest in Genoa together with Polcevera catchment, see Figure 14.

[91] Proposals of deviation of Bisagno path existed already at the end of XIX century (Luccardini, 2013)

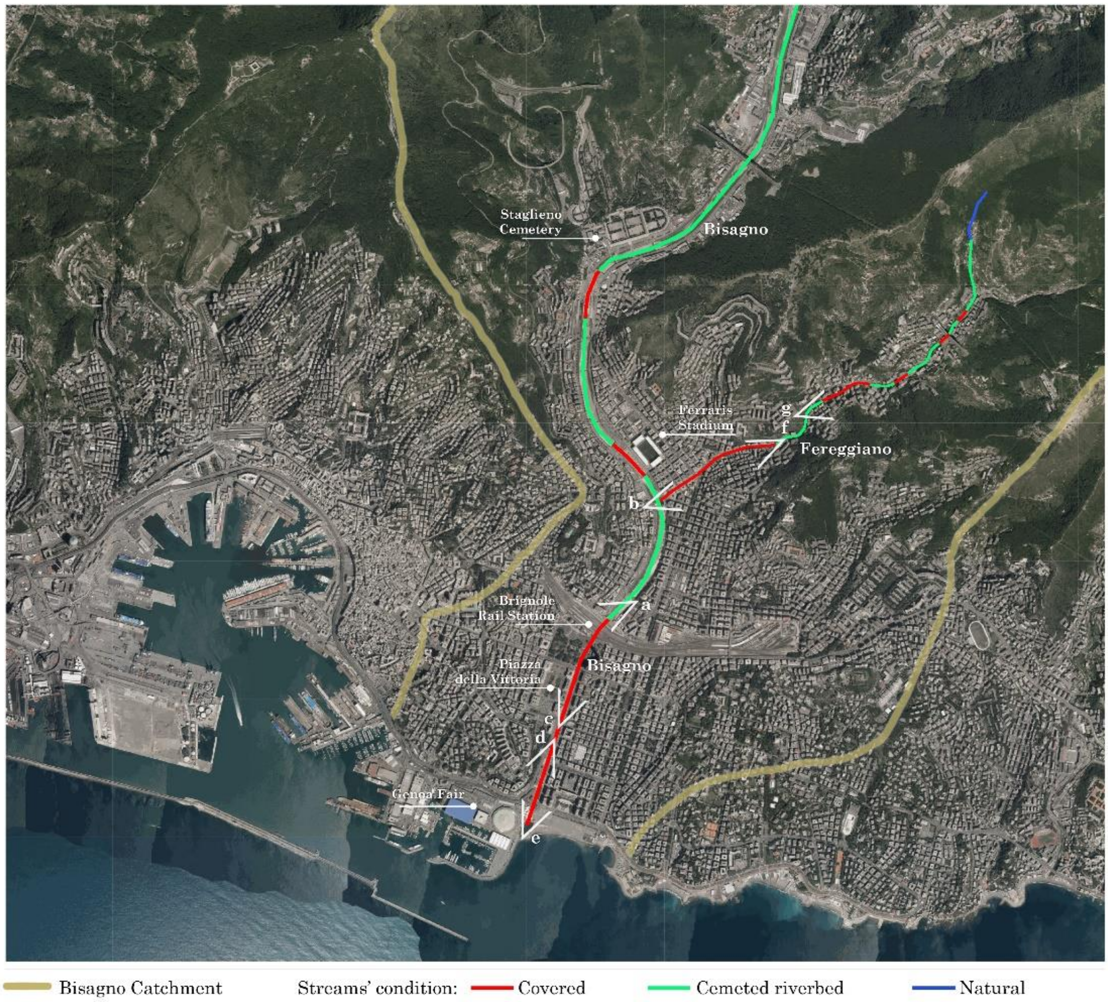

Figure 23. Southern part of Bisagno catchment. Bisagno stream and its tributary Fereggiano are completely artificialized. Elaboration of the author (Source: Genoa and Liguria Region Geoportals; background: AGEA 2016 orthophotos)

Figure 24 (**a**). Bisagno's riverbed. On the background, the bridge of the railway station "Genova Brignole" (1906): the river is covered from the railway until the sea mouth. In the front, the ruins of Sant'Agata bridge (1535[92]) progressively destroyed by 1970 and 1992 floods. (Picture by the author, May 2017)

Figure 25 (**b**). Fereggiano's inflow (channelled and covered) into Bisagno's riverbed. In the right corner, a boar: they frequently reach the city from the woods through the rivers. (Picture by the author, May 2017)

Figure 26 (**c**)

Figure 27 (**d**)

Viale delle Brigate Partigiane: the coverage of Bisagno. (Pictures by the author, May 2017)

Figure 28 (**e**). Bisagno river mouth. (Picture by the author, May 2017)

Figure 29. Warning signs indicating "floodable areas" in Foce neighbourhood (Pictures by the author, May 2017)

[92] The present bridge substituted a previous medieval bridge destroyed by a flood in 1452.

Figure 30. Warning lights in case of emergency via yellow-orange-red code[93]. (Picture by the author, May 2017)

Figure 31. Warning light indicating the flooding of Brignole Station underpass. (Picture by the author, May 2017)

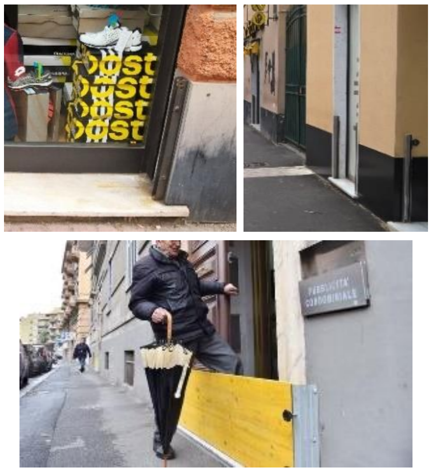

Figure 32. System of removable bulkheads for protecting shop windows and doors in case of flood. (First two pictures by the author, May 2017[94])

Figure 33 (f).

Figure 34 (g).

Figure 35 (g).

Figure 36 (g).

The beginning of Fereggiano coverage. (Picture by the author, May 2017)

Fereggiano riverbed, narrowly channelled. In fig. 34, colours indicate the warning levels of the water flow. (Pictures by the author, May 2017)

[93] See §Ch.4.3

[94] Third picture from La Repubblica website: http://www.ilsecoloxix.it/p/multimedia/liguria/2016/11/24/ASPYUFHF-pioggia_barricate_fereggiano.shtml#1

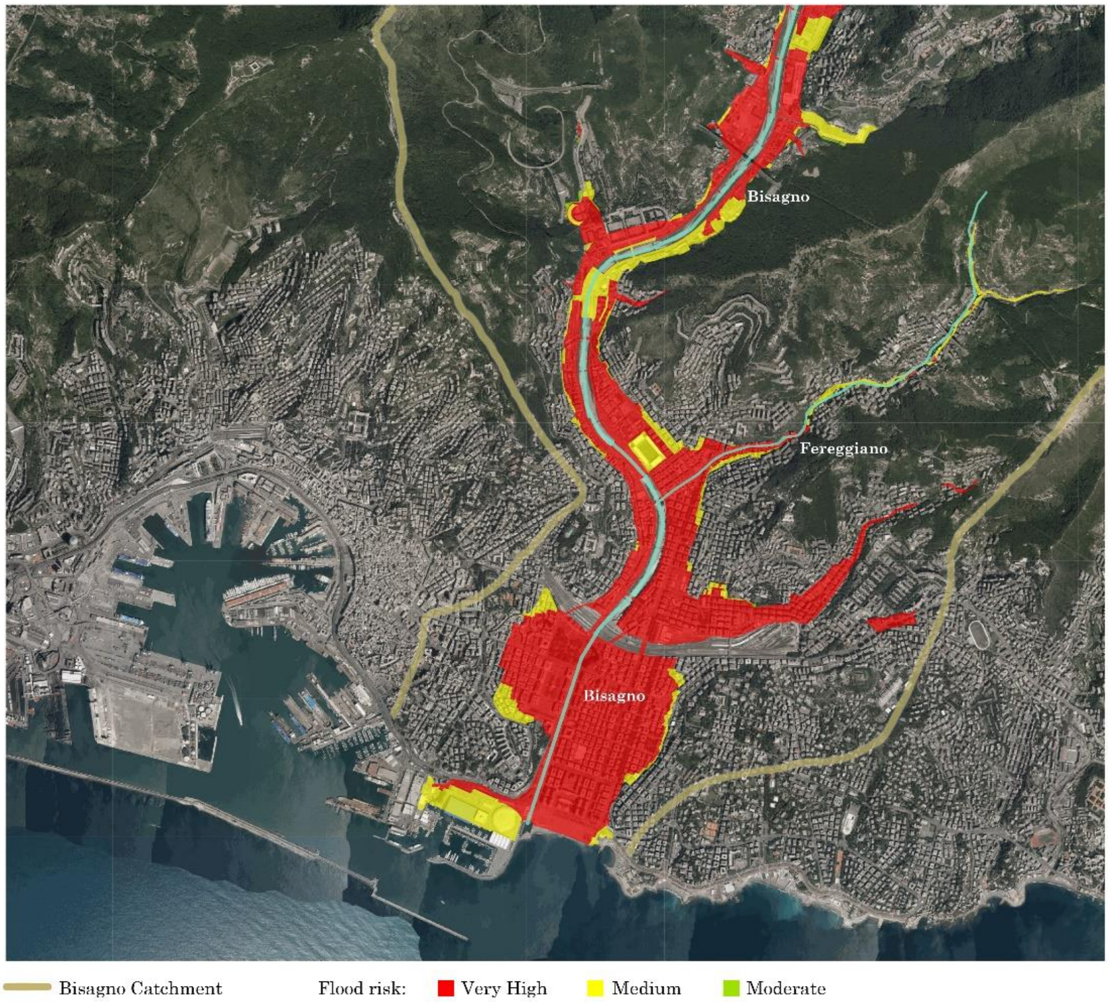

Figure 37. Southern part of Bisagno catchment: flood risk.
Elaboration of the author (Source: Bisagno Basin Management Plan, Map of Hydraulic Risk, *maps 1, 2, 3*; background: AGEA 2016 orthophotos)

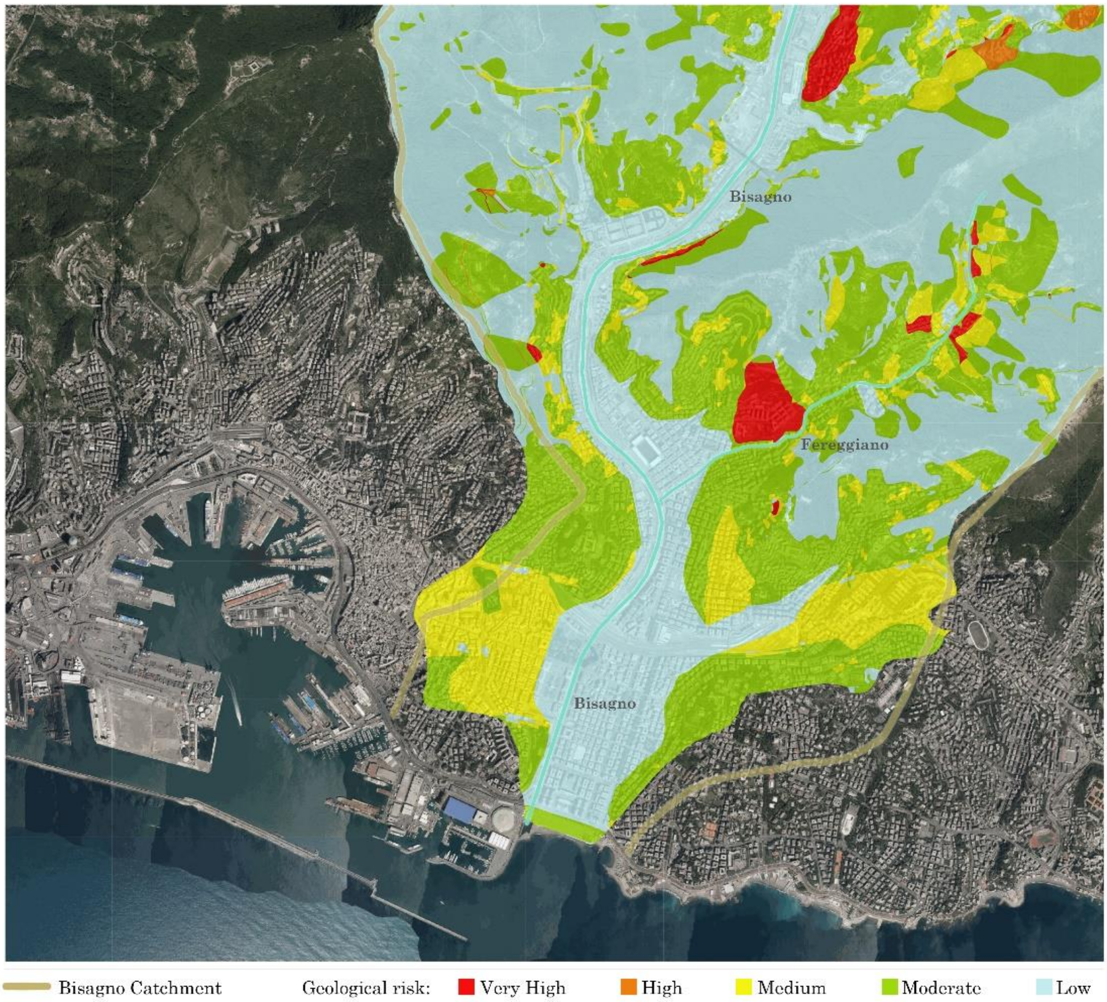

Figure 38. Southern part of Bisagno catchment: geological risk.
Elaboration of the author (Source: Bisagno Basin Management Plan, Map of Geological Risk, *map 213160*; background: AGEA 2016 orthophotos)

One century of studies and projects

Covering riverbeds for favouring the urban expansion and traffic circulation was a constant attitude of Genoa's history, and Bisagno stream represents a key example. Figure 39 shows an aerial view of the places while Figure 48 summarises the principal chronology of intervention on Bisagno river system until 2010. After a ruinous flood in October 1822, the hypothesis of transforming, channelling and covering Bisagno's southern segment gained attention (Luccardini, 2013). Specific studies about its peak flows were developed since the late 1870s, attaining very divergent results: 170 m^3/s, 600 m^3/s, 1200 m^3/s (Rosso, 2014, pp. 50-53). In 1907 the Municipality of Genoa established a Special Commission for a new evaluation of the maximum peak flows; one year later, the Commission led by prof. Fantoli determined the peak flows equal to 500 m^3/s[95]. Studies for covering Fereggiano riverbed were in progress in the same years. The project for the coverage on Bisagno was abandoned during World War I:

[95] For further details about the numerous hydraulic studies dedicated to Bisagno stream, see Rosso (2014, pp. 49-58).

works started in 1928 from the railway towards the sea, drastically reducing the river's section to a design limit of 600 m^3/s, and giving birth to the currently named Viale delle Brigate Partigiane (Figure 41, Figure 42): the road was needed also for facilitating the mobility along the two sides and towards the new "Piazza della Vittoria" (the area was known as "the Bisagno esplanade" or "Piazza d'Armi", Figure 40), redesigned and realised by the architect Marcello Piacentini during the fascist period (Figure 43). Bisagno's coverage showed an insufficient capacity already in 1951-1953 (Rosso, 2014, pp. 74-75). The underestimation of Bisagno's peak flow and of the kinetic energy of the water (which increases if channelled along smooth surfaces), the construction of the river banks that reduced the room for the river in case of heavy rains, the massive urbanization along the valley slopes and in Foce neighbourhood progressively increased the flood risk in the area.

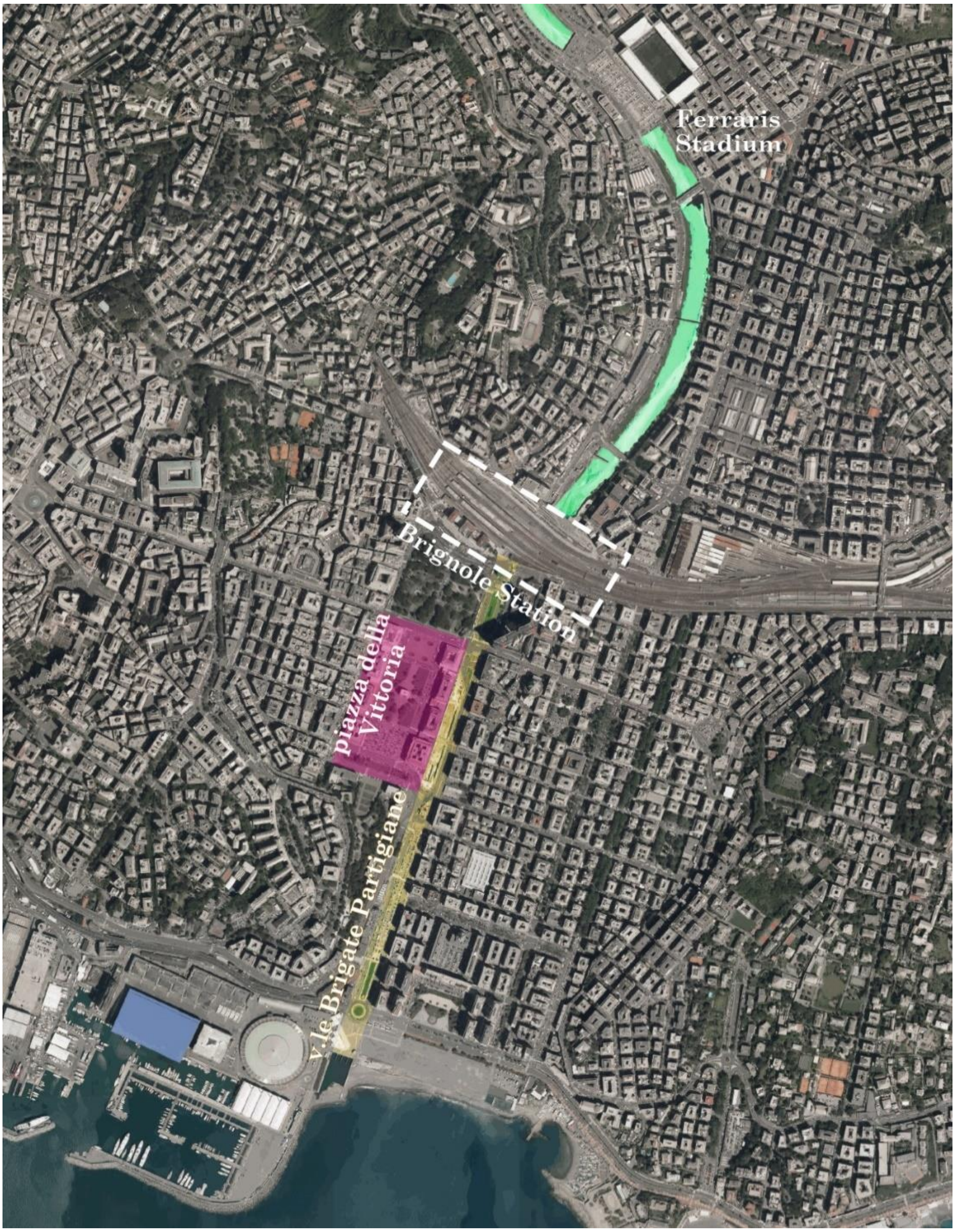

Figure 39. Edited orthophoto of Bisagno path From Ferraris Stadium to the sea (Source: Liguria Region Geoportal - background: AGEA 2016 orthophotos)

Figure 40. Piazza della Vittoria, 1922[96]

Figure 41. Bisagno coverage, 1928-29[96]

Figure 42. Bisagno coverage, 1928-29[96]

Figure 43. Monument to the Fallen in Piazza della Vittoria, 1931[96]

Figure 44. War gardens along Bisagno coverage[97]

Figure 45. War gardens along Piazza della Vittoria's staircase[98]

On 7-8th October 1970, an extreme rainfall event caused the most devasting flood in the city's history (Figure 46): Bisagno peak flow has been estimated as surely superior to 900-1000 m^3/s , equal to a return time T > 100 years (Brandolini et al., 2012, p. 950; Rosso, 2014, p. 99; Autorità di Bacino Regionale, 2017b, p. 63). Bisagno's channelled section was completely occupied by water and consequently transformed in a pressure pipe, inducing a peculiarly fast and disruptive overflowing in all the surroundings (Figure 47). In the same days various areas of Liguria were flooded causing 44 fatalities, 25 in Genoa.

[96] Pictures from Figure 40 to Figure 43 retrieved from: http://ceraunavoltagenova.blogspot.com/2013/05/

[97] Retrieved from: http://senato.archivioluce.it/senato-luce/scheda/foto/IL3000001228/12/Mietitura-del-grano-in-un-ampio-viale-della-cittagrave-nei-pressi-di-piazza-della-Vittoria-attuale-viale-delle-Brigate-Partigiane.html

[98] Retrieved from: http://senato.archivioluce.it/senato-luce/scheda/foto/IL3000001206/12/La-scalinatagiardino-di-piazza-della-Vittoria-con-aiuole-trasformate-in-orti-di-guerra.html

According to Bisagno River Basin Authority (Autorità di Bacino Regionale, 2017b, p. 56), the flood caused damages for 10 billion Lire, equal to more than 90 million euros in 2018[99].


IL SECOLO XIX

Dopo il tragico bilancio dell'alluvione: 16 morti 9 dispersi, 200 miliardi di danni

GENOVA RESISTE

Aiutiamoci

APRIAMO UNA SOTTOSCRIZIONE

Colombo ci dichiara «Aiuteremo Genova»

Ha ripreso a piovere

Figure 46. Frontpage of Genoa's *Il Secolo XIX* Newspaper on 10th October 1970[100]

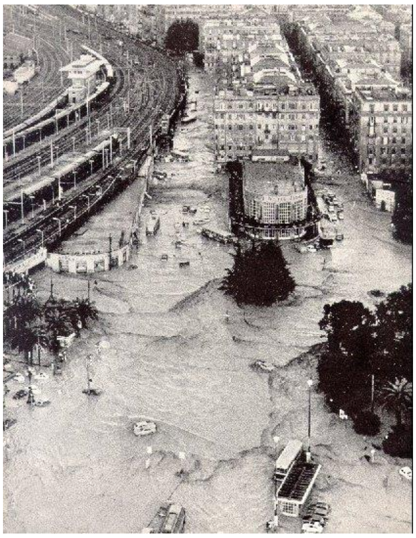

Figure 47. Brignole station area during 1970 flood[101]

After the disaster, a special Commission led by prof. Supino was established by the Ministry for Public Works for evaluating possible solutions for reorganizing the water courses involved in the flood : the Commission prosed the construction of an underground floodway tunnel to reduce the peak flow of the stream[102] and that "would have allowed to further cover the riverbed in future" (Rosso, 2014, p. 102).

[99] The economic impact of 1970 flood varies deeply according to different authors. According to Rosso (2014, p. 94), the flood caused damages for 130 billion Lire, equal to more than 1,2 billion euros in 2010. For Faccini and colleagues, 19 billion euros (2015, p. 2637).

[100] Retrieved from: http://www.ilsecoloxix.it/p/multimedia/liguria/2014/10/11/ARIApoDC-stessa_secolo_rabbia.shtml#2

[101] Retrieved from: https://genova.repubblica.it/images/2011/11/04/154000651-716e281f-c57a-48bd-ba85-d9bc69f5869a.jpg

[102] Other options analysed – but negatively evaluated because not sufficient for effectively reduce the flood hazard – were: a pressure pipe, two retention basins, the redesign of the coverage (Rosso, 2014, p. 100)

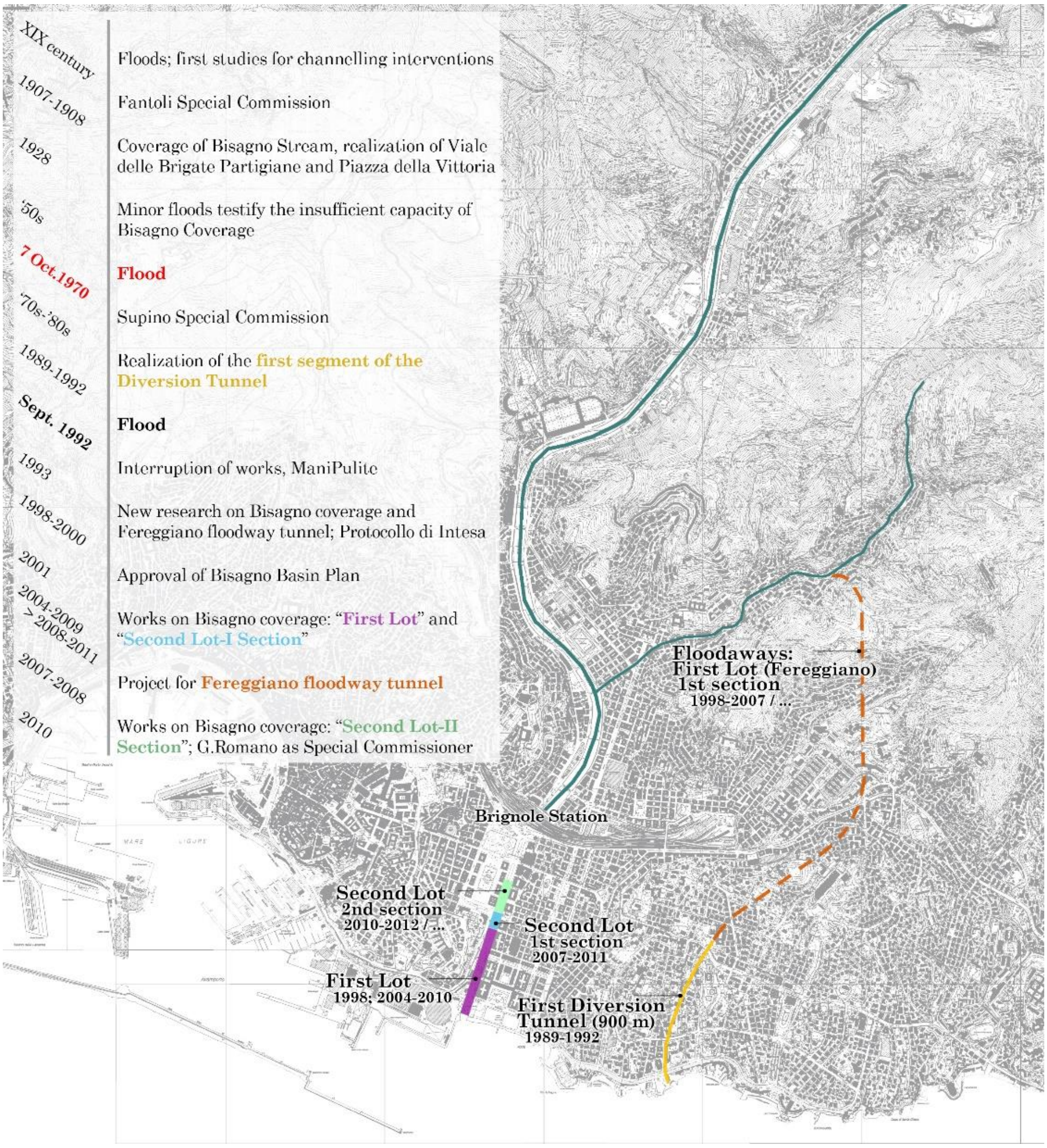

Figure 48. Chronology of Bisagno floods and infrastructural mitigation projects up to 2010. Elaboration of the author (projects available from official websites; background: Genoa Geoportal, Technical Regional Map 2007)

In the '70s and '80s, new hypotheses for increasing safety of Bisagno and Fereggiano streams gained credibility in the local debate, especially the possibility of a total diversion of Bisagno (differently from Supino Commission proposal), or the demolition of the '20s coverage. The tunnel was imagined as an infrastructure able to diverge almost entirely Fereggiano, Rovare and Noce streams (Bisagno's tributaries) to the sea, along Corso d'Italia. A first segment (≈ 900m) of the diversion tunnel was designed and realised by the concessionary firm Italstrade between 1989 and 1992 as part of the works for the 1992 Genoa Expo (better known as "*Colombiadi*"), but between 1992 and 1993 the works for the diversion tunnel were interrupted because of growing technical, economic and legal conflicts between the Municipality of Genoa and Italstrade. In the meantime, in September 1992 Bisagno flooded violently in Borgo Incrociati and Marassi areas[103] damaging also the Ferraris Stadium freshly renewed by the Italian architect Vittorio Gregotti for hosting the 1990 FIFA World Cup. Saint Agata's bridge (Figure 24) collapsed, already damaged by the 1970 flood. The disaster opened up the debate about the recurrent floods in the city: La Stampa newspaper titled on "The sky is innocent: it's urban planners' fault" (Fazio, 1992). The tunnel was abandoned, not before being even object of investigations inquiring cases of political corruption in the city[104]: the inquiries in Genoa were linked to the large "*Mani Pulite*" case ("Clean Hands") started in 1992 in Italy investigating widespread corruption between the political and entrepreneurial world all over the country.

In 1998 new studies about Bisagno's flood risk started again – connected to the design of Bisagno's first Basin Plan[105] – reviving also the project of the floodway tunnel proposed by Supino Commission: "in December 1996, the damage associated with flood events that had affected the Bisagno basin from 1945 to 1996 was discounted with a value of many billions of Lire, without taking into account the fundamental aspect related to the loss of human lives. This meant that, over a period of about 50 years, the value of just the material damage was completely comparable with the cost of a structural public work able to guarantee the discharge of a two hundred years peak flow" (Rosso, 2014, p. 123). In October 1998 the Municipality of Genoa, the Province of Genoa and Liguria Region signed a Public Agreement ("*Protocollo d'Intesa*") for the design and implementation of structural interventions aimed at mitigating the Bisagno's hydraulic "emergency", redefining both the urban planning of its terminal section and the environmental regeneration of the riverbeds. According to the agreement:

- the Province of Genoa was in charge of the preliminary project for Bisagno floodway, able to reduce also the hydraulic criticalities involving the tributaries Fereggiano, Rovare and Noce
- the Municipality of Genoa led the design of the preliminary project for the upgrade of Bisagno coverage and the expansion of its outflow sections
- the Liguria Region oversaw functions of interinstitutional coordination and fundraising

The floodway and the upgrade of the coverage together should have ensured a flow rate of about ≈1.300 m^3/s, in the limits of 200 years flood. At the beginning of 2000s, the plans for the floodway tunnel and the re-building of Bisagno coverage were object of contracts, preliminary designs and fund assignments, but prioritizing the intervention on the coverage along viale delle Brigate Partigiane. In March 2004 a budget of 70 million euros was approved for "improving the outflow conditions of Bisagno stream" (OPCM. 3344, 2004): the upgrade of the coverage involved the river mouth, specifically the last 550 m until the shoreline ("First Lot" and "Second Lot-I Section"; "*Primo lotto*" and "*Secondo lotto-Primo stralcio*") (Figure 48). Works were approved and assigned between 2004 and 2008 and completed in 2009/2011[106]: for ensuring a higher flow rate (≈850 m^3/s), the riverbed was lowered, and the thickness of the new coverage was reduced.

[103] Borgo Incrociati is an ancient neighbourhood grew along the right bank of Bisagno, just north of Brignole Station; Marassi neighbourhood is on the left bank of the river, above Fereggiano stream.

[104] The City Councillors Timossi (Urban Planning Department) and Saitta (Streets Department) were prosecuted in 1993 and acquitted of all charges in 2004.

[105] The plan was approved in December 2001. As mentioned above, Liguria's basin plans were among the first approved in Italy, following Law no. 183/1989 and Law no. 267/1998.

[106] Information available on Genoa Municipality and Liguria Region official websites: http://www.comune.genova.it/content/copertura-bisagno-2°-lotto-–-2°-stralcio;

For what concerns the floodway, following the 1998 Agreement, the Province of Genoa – in charge also of the design of the Basin Plans by LR. no. 9/1993 – moved forward the design of the floodway tunnel, between 2000 and 2007. The project was approved only "technically" by the Province of Genoa in October 2007 since there was no budget available for financing the works (Autorità di Bacino Regionale, 2017a, p. 40): the positive assessment by the Supreme National Council of Public Works ("*Consiglio Superiore dei Lavori Pubblici*") followed between December 2007 and February 2008 (Vote n° 282/2007 and Counsel n° 23043/2008). As described by an official of Liguria Land Defence Department, "the Province 'crazily' invested in the preliminary project for Fereggiano floodway through a basilar cost-benefit analysis: the damages caused by a Bisagno flood were almost equivalent to the cost of the tunnel, on the hypothesis of 20-25 years flood return time".

In September 2010, the Ministry for Environment and Liguria Region signed a "Program Agreement" ("*Accordo di Programma*") for planning and financing urgent actions to mitigate hydrogeological risks in the region[107], allocating ≈ 35 million euros for the Second Lot-II section of works on Bisagno coverage[108]. On 11th October, a Decree of the President of the Council of Ministers appointed Giuseppe Romano (former Prefect of Genoa) as Special Commissioner for the works involving Bisagno stream.

The 2011 flood

The process for moving forward the projects both for Bisagno coverage and for the floodway tunnel were still under way on 4th November 2011, when a new flash flood involved the basin. A rare amount of precipitation fell in an area of few square kilometres with very high intensities in about 5-6 hours: at midday rain gauges in Fereggiano area reported 479 mm rainfall, and the rain depth estimated is recognised as rare, with a return period T among 200 and 500 years (Silvestro et al., 2012, pp. 2749-2750). Fereggiano stream flooded violently in via Fereggiano (Figure 49 to Figure 51) causing 6 victims[109] killed by the flood wave: while trying to find shelter in the entrance hall at street number 2, they were dragged inside the building basement by the mud flood. Bisagno flooded as well, and large inundations involved Borgo Incrociati (Figure 53), Brignole Station (Figure 54) and Foce neighbourhood. The damages have been evaluated in ≈155 million euros (Faccini et al., 2015, p. 2637). Bisagno flooded reaching a peak flow with Return Period (T) around 30 years (Silvestro et al., 2016, p. 1738).

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https://www.regione.liguria.it/homepage/infrastrutture-e-trasporti/interventi-urbanistici/rifacimento-della-copertura-del-torrente-bisagno/rifacimento-della-copertura-del-torrente-bisagno-cronoprogramma.html

[107] "*Accordo di Programma*" signed on 16th September 2010, available at http://www.rendis.isprambiente.it/rendisweb/adp/@DecN$AP_LIGURIA_16-09-2010.pdf

[108] Other 3 million euros were added on December 2013.

[109] The victims were all women, between 10 months old and 50 years old. Interviews with both victims' relatives and Mayor Vincenzi were published by Laura Nicastro (2012).

Figure 49. Via Fereggiano, 2011 flood. The building on the left (no. 2) trapped the 6 victims[110]

Figure 50. Via Fereggiano, 2011 flood. The building on the right (no. 36) was demolished in 2016-2017 for enlarging the streambed[111]

Figure 51. Via Fereggiano, 2011 flood[112]

Figure 52. Volunteers ("*Angeli del Fango*") in Corso Sardegna[113]

Figure 53. Borgo Incrociati, 2011 flood[114]

Figure 54. Brignole Station, 2011 flood[115]

The mayor Marta Vincenzi[116] and other 5 officials of the Municipality responsible for Civil Protection interventions were investigated since December 2013 for faulty disaster management. In November 2016 they were found guilty for negligent homicides, disaster, and false statement in government documents. The second appeal, started in November 2017, confirmed the first verdict of the Court in March 2018 with an aggravation of the punishments. The Mayor and the other defendants had enough information to close streets and schools in advance, and therefore reduce the number of causalities, according to the Court: indeed, five of the six victims were on the road to pick up the kids from school. The

[110] Screenshot from YouTube video: https://www.youtube.com/watch?v=P0iiL_mFndU

[111] Screenshot from YouTube video: https://www.youtube.com/watch?v=szWl34ufwe4

[112] Picture from Il Secolo XIX newspaper: http://www.ilsecoloxix.it/rf/Image-lowres_Multimedia/IlSecoloXIXWEB/genova/foto/2012/11/02/alluvione_GENOVA_0411/alluvione_ge_06_ok.jpg

[113] Picture from SkyTG24: https://tg24.sky.it/cronaca/photogallery/2011/11/07/volontari_genova_liguria_maltempo_allluvione_angeli_col_fango_sulle_magliette_facebook_foto.html#5

[114] Picture from http://www.ilnuovocantiere.it/esondazioni-del-bisagno-misure-per-la-messa-in-sicurezza-di-genova/

[115] Picture from: http://polaris.irpi.cnr.it/event/alluvione-a-genova/

[116] Genoa's recent mayors: Marta Vincenzi (Partito Democratico, centre-left) 2007-2012; Marco Doria (Sinistra Ecologia e Libertà, centre-left) 2012-2017; Marco Bucci (centre-right), from 2017.

charge of “false statement” is referred to official minutes in which the hour of Fereggiano flood was manipulated to make the violent flooding seem “unpredictable”: from the official record, the overflooding seems occurred in about 20 minutes around midday, giving “no time” for operating any emergency intervention. On the contrary, according to the judges, witnesses and videos described a longer time range between Fereggiano water rise and the flood wave (Nicastro, 2012, pp. 90-91).

4.3 “AFTER-THE-FLOOD(S)” PROJECT HISTORY

After the 2011 flood, two streams of facts involved the projects for risk reduction ongoing in Bisagno valley, drawn in Figure 57. On the one hand, the administrative procedures and the implementation of works on Bisagno were frozen between 2011 and 2014 because of a series of appeals and counter-appeals filled by the firms involved in the public calls for tenders for the Second Lot-II section, and by the related divergent pronouncements by the State Council and by both Liguria and Lazio Regional Administrative Courts. On the other hand, in 2012 Law no. 134 launched a “National Plan for Cities”, managed by the Ministry for Infrastructures and Transports (L. 134, 2012): nevertheless the Plan’s goals were mainly dedicated to “enhancing urban quality”, the city of Genoa obtained 25 million euros proposing a wide project for risk reduction in the Bisagno basin (costs estimated in 221 Million Euros), including Fereggiano floodway as “first lot” of the larger scale program, revising the projects already defined in early 2000. The National Plan indeed prioritized projects ready to be implemented (“*progetti cantierabili*”). Genoa’s was one of the largest sums granted by the Plan for Metropolitan Cities. The Municipality of Genova and Liguria Region added 15 and 5 million euros; other 5 million euros were funded later by “Mission Structure against hydrogeological instability and for the development of water infrastructures” (“ItaliaSicura”, “Safe Italy”) within its special “Plan for flood risk reduction in Metropolitan Areas” (DPCM. 15 settembre, 2015) (§Ch.3.2).
In May 2013 the Liguria Region, Genoa Province and Genoa Municipality renewed the common agreement for the design and implementation of works, while Romano resigned from his role of Special Commissioner for Bisagno in June 2013, substituted the following year temporarily by the Mayor Doria and definitively by the President of Liguria Region[117] (L. 116, 2014). The project for the floodway was finally approved by the Superior National Council of Public Works and by the Municipality of Genoa in 2014, and the interinstitutional agreements between Ministry of Infrastructure, Liguria Region and Genoa Municipality led to open the call for public tenders in summer 2014, won by PAC S.p.A. engineering firm.
In the same period, efforts for upgrading Bisagno coverage had a new beginning: in July 2014 Lazio Regional Administrative Court dismissed previous pronouncements and reopened the administrative procedures for finally entrusting the same firm consortium[118] who firstly won the public tender for the Second Lot-II Section in 2012.

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[117] In May 2015 Giovanni Toti (Forza Italia, centre-right wing) was elected new President of Liguria Region, consequently “Special Commissioners for the implementation of hydrogeological risk reduction projects” according to Law no. 116/2014. Former President (2005-2015) was Claudio Burlando (Partito Democratico, centre-left wing)

[118] Firms: Sirce, Vipp, Tre Colli

Few months after Lazio Court decision, Bisagno flooded again on 9th-10th October 2014 with a return time T ≈ 90 years (Autorità di Bacino Regionale, 2017b, p. 61), causing a victim near Brignole Station.

Figure 55

Figure 56

Bisagno 2014 flood in Brignole Station area[119]

Another flood only three years after the 2011 disaster gave again strength to scientific, political and social debates and polemics about the delay and inefficiency of the public action and local governance in addressing flood risk in the city: in three years the city lived a forty-years (2011) and ninety-years (2014) floods (Autorità di Bacino Regionale, 2017b, p. 63). One month later, on 15th November 2014, Bisagno risked to flooding again, while large west sectors of the city experienced serious floods and landslides from Voltri to Sampierdarena (ARPAL Regione Liguria, 2015): "in November 2014 we almost lived the simultaneous flooding of Bisagno and Polcevera, which would mean locking Genoa and handing over its keys" (interview with former Council Member). Figure 57 summarises the chronology of the works for Bisagno coverage and for Fereggiano and Bisagno floodway.

[119] Pictures from La Repubblica newspaper: https://genova.repubblica.it/cronaca/2014/10/10/foto/brignole_-97750501

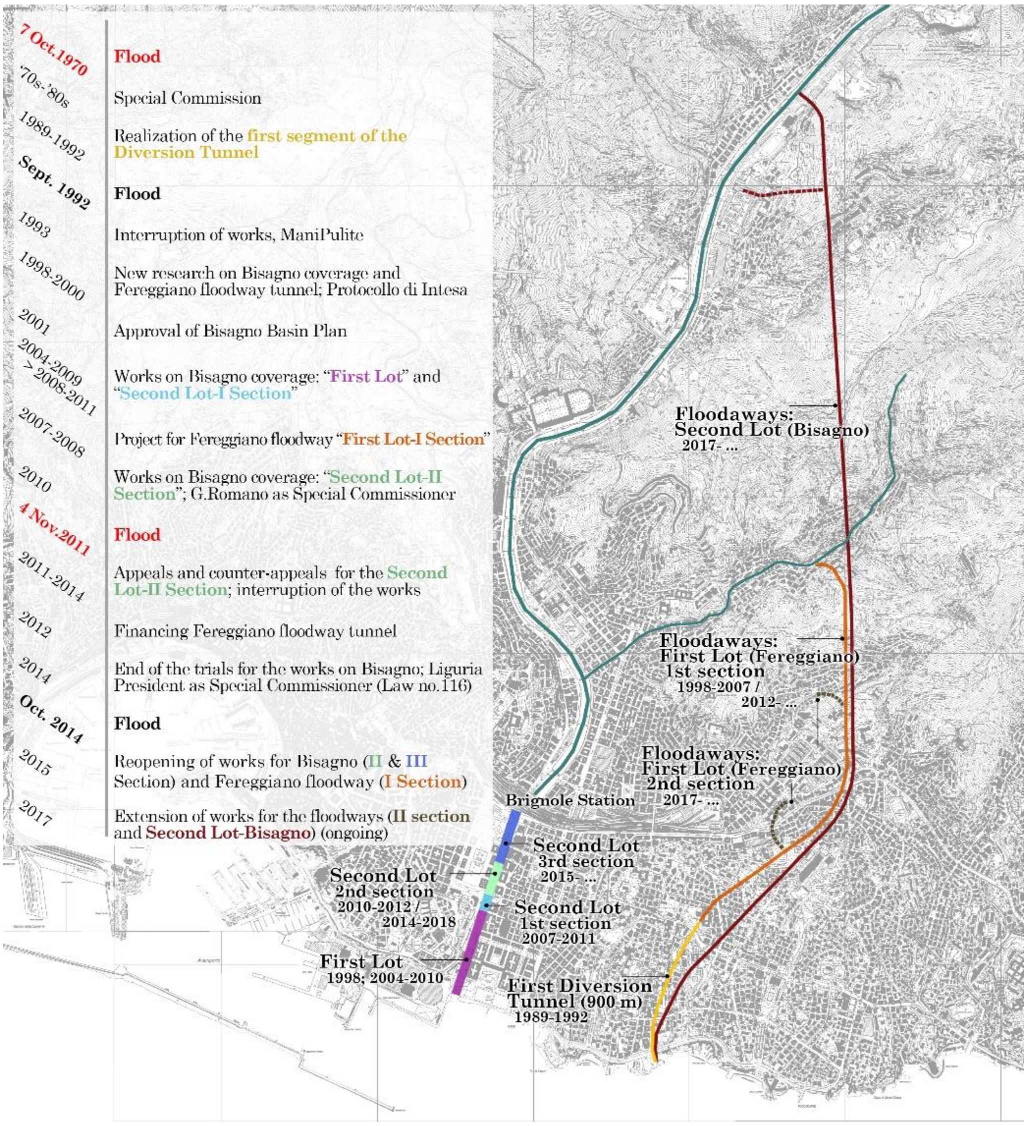

Figure 57. Chronology of Bisagno floods and infrastructural mitigation projects up to 2018 – evolution from Figure 48. Elaboration of the author (projects available from official websites; background: Genoa Geoportal, Technical Regional Map 2007)

April 2015 signed the reopening of the public works in the area. Interventions for Fereggiano floodway started reusing the first 900 metres already realised in early '90s that will work as common sea-mouth of both Fereggiano and Bisagno floodways when the entire infrastructural system will be completed. Fereggiano floodway (First Lot-I Section) is an underground tunnel 3,7 km long and 5 metres large, able to drain ≈111 m^3/sec. The floodway tunnel will also drain water from Noce and Rovare creeks (II Section, financed by ItaliaSicura with 10 million euros). When completed, Fereggiano floodway will drain 160 m^3/sec, able to mitigate floods with 200 years return time. The only visible working site is the tunnel's sea mouth along Corso d'Italia (Figure 58 to Figure 60): all the works are happening underground (Figure 62) with 24/7 working hours; the excavations proceed from the existing diversion tunnel towards North through mini-explosions[120]. For ensuring the efficacy of the drainage system also under pressure (in case of extreme rains) the project includes four air intakes ("*aerofori*"): namely four vertical pipes from 30 to 100 meters deep with a diameter

[120] In May 2017 the tunnel had reached San Martino Hospital: three series of explosions per day were clearly audible.

of 90 centimetres, which will emerge on the surface for 2,5 meters[121]. The connections between the riverbeds and the floodway are a multilevel drainage system which consents to control water volumes and flows according to flood conditions, and to completely isolate the riverbed and the floodway for allowing maintenance works in both (Figure 63).

Figure 58

Figure 59

Figure 60

Working site of the floodway sea mouth along Corso d'Italia. (Pictures by the author, May 2017)

Figure 61
Floodway sea mouth[122]

Figure 62
Internal view of the floodway[123]

Figure 63
Fereggiano stream: area of (future) intersection with the floodway.
(Picture by the author, May 2017)

As for Fereggiano, works on Bisagno coverage started again in April 2015, reopening the Second Lot-II Section working site[124] (Figure 64 to Figure 65) that was closed in January 2018. The interventions on the III Section[125] (the last segment, involving Brignole Station area) were assigned to ITINERA S.p.A in autumn 2016 and started one year later (Figure 68 to Figure 71); the conclusion is expected by July 2020. ItaliaSicura's National Plan for Metropolitan Areas funded 95 million euros for this last works on Bisagno coverage. The project for the Second Lot – namely the Bisagno floodway – was assigned in August 2017 to Rocksoil S.p.A.[126]: 165 million euros have been entirely funded by ItaliaSicura with the Plan for Metropolitan Areas. This floodway will be 6,5 km long with a diameter of about 10 metres, able to discharge 450 m^3/s, almost half volume of Bisagno's 200 years flood.

[121] http://www.comune.genova.it/content/scolmatore-del-fereggiano-scheda-di-progetto

[122] Picture from website: http://www.scolmatorefereggiano.it/cache/ztshortcodes/images/sliderimg/resized_24.jpg

[123] Picture from website: http://www.scolmatorefereggiano.it/cache/ztshortcodes/images/sliderimg/resized_3.jpg

[124] http://www.cantierebisagno.it/

[125] http://www.cantierebisagnolottofinale.it/

[126] Rocksoil is involved also in the railway project "Terzo Valico", a high-capacity path for facilitating the connections between Genoa and northern regions, especially Piedmont and Lombardy. Rocksoil was founded in 1979 by Pietro Lunardi, Minister of Infrastructures and Transports in 2001-2006 (Berlusconi Governments, centre-right wing).

Figure 64

Figure 65

Viale delle Brigate Partigiane, works on Bisagno coverage (Second Lot, II Section). Pictures by the author, May 2017

Figure 66

Figure 67

View of viale delle Brigate Partigiane, works on Bisagno coverage (Second Lot, II Section). Pictures from the project website[127]

Figure 68

Figure 69

Viale Duca d'Aosta/Brignole Station, works on Bisagno coverage (Second Lot, III Section): in fig. 32 on the left, the railway bridge. Pictures by the author, September 2017

Figure 70

Viale Duca d'Aosta/Brignole Station, works on Bisagno coverage (Second Lot, III Section). Picture from Google Street View, May 2018.

Figure 71

Brignole Station, works under the railway bridge (Second Lot, III Section). Picture from the project website, August 2018[128]

[127] http://www.cantierebisagno.it/?p=3795

[128] http://www.cantierebisagnolottofinale.it/chiusura-notturna-corsia-verso-nord-tunnel-canevari-dal-3-al-6-settembre-2018/

The new weather alert system

The Liguria Region issued a new legislation in October 2015 (Delibera della Giunta Regionale della Liguria 1057, 2015) reorganising the weather alert system and the consequential civil protection procedures. On the one hand, Deliberation no. 1057 was issued for fulfilling both general laws: the 2004 Directive of the President of the Council of Ministers about the management of the national alert system (Direttiva PCM 27 febbraio, 2004) and several following indication of the National Civil Protection; the Legislative Decree implementing the European Floods Directive which required Italian Regions to define warning system for civil protection purposes inside the Flood Management Plans (DLgs. 49, 2010) (§Ch.3); the Regional Law no.15/2015 which redistributed land defence responsibilities from Provinces to Genoa Metropolitan City and Liguria Region (LR. Liguria 15, 2015). On the other hand, the deliberation openly recalls Liguria's recent floods: "the regional warning system must be integrated also because of the past experiences due to the exceptional events that have affected the Ligurian territory in recent years". Deliberation no. 1057 defined an alert system based on "four colours code": Green (no alert), Yellow (significative phenomena), Orange (intense phenomena) and Red Alert (very intense phenomena). This system replaced the previous definitions, more generic and based on "Alert Level 1" or "2"[129]. Arpal (Regional Agency for the Protection of the Ligurian Environment) and Liguria Region define the Alert Level from Yellow to Red according to weather forecasts. Consequently, each municipality activates its civil protection groups and the pre-planned activities according to the risk level, reducing discretional or impromptu choices. Consequently, an indirect responsibility for the indication of the Alert State – and its consequences – has been relocated from institutions to meteorologist experts[130].

Figure 72. On the left, a poster about flood risk from Genoa Civil Protection's 2017 Campaign. On the right, the poster at a bus stop. (Picture by the author, September 2017)

For instance, in Genoa in case of Yellow Alert all working sites in riverbeds are closed; in case of Orange Alert underpasses are closed and special parking rules are applied in the most vulnerable areas; in case of Red Alert all educational institutions, municipal museums and libraries, sport facilities and parks are compulsorily closed[131]. The new system included a large-scale communication plan underling the importance of citizens' self-protection

[129] The National Department of Civil Protection completed and enforced a new standardized alert system for all Italian Regions in February 2016 (Dipartimento della Protezione Civile, 2016), very similar to 2015 Liguria protocol.

[130] A professor of Genoa University ironically but benevolently described the experts of the regional weather agencies as forced to act as "Modern Rain Wizards".

[131] http://www.comune.genova.it/content/misure-precauzionali-caso-di-allerta-tabella-riassuntiva

measures, indeed information about weather forecast and alerts are available for the population through: three institutional websites[132], social media pages of the Municipality of Genoa and Local Civil Protection, a phone app "*Io non Rischio Genova*", two toll-free text messaging[133] and phone numbers. Road electronic panels and advertisements complete the communication strategy (Figure 72). Genoa's civil protection and School Department ("*Ufficio Scolastico Territoriale*") implemented a project of multilingual translation of the alert system "Safety without Borders"[134]: volunteers translated the handbook in Albanian, Arabic, Dari, French, English, Spanish, Romanian, and Genoese dialect.

4.4 DISCUSSING GENOA: A HISTORY OF ROUND-TRIPS BETWEEN PROJECTS, STRATEGIES AND FUNDS

The case of Genoa shows that the main causes of urban risks do not lie "simply" in the technical limitations or economic constraints (and in the history of Genoa's urbanization) but are rooted in the complex relations among accumulated outdated praxis, normative limitations, lack of design activities in times of peace[135].

Reducing hazard or reducing exposure and vulnerabilities?

Flood risk reduction (in Genoa, and elsewhere) is still implemented mainly through actions focused on the attenuation of flood *hazard*, by building floodway or diversion tunnels, re-creating more space for accommodate water flows; the reduction of flood risk by addressing *exposure* and *vulnerability* to the hazard appears still neglected but essential (§Ch.1.1). Genoa's case represents a distinct example: the ancient and modern urban fabrics with their multiple (social, economic, cultural) values, and the harsh morphology of the territory do not allow large modifications of the urban space – save for very expensive and invasive interventions, or building relocations, expensive and unpopular; consequently, the reduction of risk through infrastructural hard interventions represent the most known and feasible – often necessary and most effective – path to follow in cities. Nonetheless, projects of urban retrofitting – that will undoubtedly augment in future decades – can contribute to overall risk reduction by regaining small spaces for water[136], adapting cities towards "more hydrophilic" paths of transformation, as confirmed by interviews (interview with a hydraulic engineer from CIMA Foundation and with an Official of Genoa Municipality) and could also allow to better address multiple hazards together. Since Italian floods generally last few hours, a planned coexistence with water wouldn't affect urban systems for long times and could be accepted and managed in many cases. As recalled by an expert from CIMA foundation: "we should start thinking about resilient urban structures and fabrics, able to cope with minor floods. What is

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[132] www.comune.genova.it; www.allertaliguria.gov.it; www.meteoliguria.it

[133] In February 2017 about 116.000 people were registered to the messaging systems and the system is growing, as narrated by an interviewee. In March 2018 press reported that the Genoa Municipalities sent more than 4 million text messages since 2014.

[134] Information about the project and its handbook are available at http://www.comune.genova.it/content/sicurezza-senza-confini

[135] The results of Anna Scolobig's recent research (2016, 2017) about the political root causes of risk in Genoa confirm part of the author's investigations.

[136] These assumptions are inspired by the Dutch "Living with Water" concept (van Herk, Rijke, Zevenbergen, & Ashley, 2013; Zevenbergen et al., 2013). The Appendix of this thesis explore examples of nature-based solutions.

intolerable is the death and damage toll after each flood, and the lack of preparation of cities" (interview). On the one hand, interventions of building demolition – such as along Chiaravagna (from Figure 16) or Fereggiano streambed (Figure 50) – reduce exposure but are very difficult to implement because of barriers as (§Ch.2.1): legal ownership rights to compensate; high expropriation and demolition costs; technical complexity (e.g. works need to be implemented in multiple stages, because of the extension of the affected areas and expensive costs); social resistance due to the indispensable housing displacements and to the general difficulties triggered by working sites (e.g. impacts on traffic and transportation) for local communities.

Interventions that do not transform urban surfaces – like the operations chosen for Bisagno and Fereggiano – are often preferred because they do not interfere with the public and private spaces that define the existing urban structure (as confirmed by interview with Official of Genoa Municipality and by an expert from CIMA foundation). The spatiality of risk reduction interventions is therefore a missed topic because they are "*reduced*" to specialized, urgent, post-disaster engineering solutions, addressed "river-by-river"[137] and – with a bit of luck – underground. The case of the building in via Giotto no. 15 (see note 81) is extremely interesting because it was not an "illegal" building: the initial building activity was legally approved inside Chiaravagna riverbed even if rivers are "state property" ("*Demanio dello Stato*"). Therefore, a long and difficult trial was necessary to resolve the accumulated ownership rights demanding very high expropriation costs and to proceed with the acquisition and demolition, nevertheless the known evidence about the flood risk in the area. Large public funding (e.g. reconstruction funds from the National Civil Protection) were needed to compensate the owners: shortly, public institutions "bought the building" for destroying it.

On the other hand, interventions aimed at reopening covered streams and making room for the rivers need wide spaces often unavailable in urban contexts and therefore generate spatial transformations that need to be designed, discussed and managed; finally, they require also to cope with the issue of water quality of urban streams: the water quality and the state of riverbeds are often so insalubrious in cities that keeping streams covered can be the only feasible option. Projects aiming at facing floods by "living with water" run the risk of being a utopia in urban contexts if not combined with the reduction of water pollutants and serious strategies of land management: for the same reasons, they represent an opportunity for increasing environmental urban quality and stimulate urban design innovation.

The reduction of exposure and vulnerability to flood hazard needs to acquire larger attention and integration in risk governance not only for fostering scientific and technical innovation achieving hopefully more effective results, but because the reduction of flood risk only addressing the hazard component require unbearable economic resources.

The implementation of the new alert system and the wide communication campaign about flood risk and self-protection measures for incrementing citizens' awareness represents a supplementary but pivotal measure for reducing the population vulnerability in the city, confirmed by professors and research interviewed (who answered both as experts and as citizens). Interviewees underlined the importance of not only "informing" the population at risk but involving it in the definition of emergency strategies and plans: an attainable goal, above all in little towns.

[137] Interventions for risk reduction are "listed" river-by-river also in the dedicated webpage in Genoa Official website: http://www.comune.genova.it/cantieri

The praxis of reactive approaches to risk reduction

The Italian inclination for reactive post-emergency interventions rather than for prevention activities has been discussed in §Ch.3.3. Genoa case here presented confirms how projects for flood risk reduction are predominantly moved by the last flood experienced. As stated by three interviewees (an official of Liguria Land Defence Department, an official of Genoa Municipality and a professor of planning of Genoa University) all governments intervene *in-situ* – where the flood struck – and *ex-post* – after the disaster – narrowly missing overall analyses showing "short-sighted logics and pernicious delays". The limits of a reactive approach are particularly evident in Genoa's territory where flood frequency is high and the consciousness about local flood risk is widespread both as scientific knowledge and research engagement on the one hand, and as political and social awareness – due to the recurrence of large floods – on the other hand. Furthermore, the economic impact of Genoa's floods is extremely high (Table 6):

Flood	*Damage losses (€)*	*Budget for mitigation interventions on Bisagno*
October 1970	19 billion (see note 99)	
September 1992	125 million	1990s: Estimated 55 billion Lire for Fereggiano floodway (Rosso, 2014, p. 111) – works suspended
September 1993	800 million	
October 2010	96 million	2004: 70 million euros 2010: 35 million euros 2012 (National Plan for Cities): 45 million euros 2015-2017 (ItaliaSicura funds): 285 million euros
November 2011	155 million	
October 2014	250 million	
Tot 1992-2014:	*1426 million euros*	*435 million euros*

Table 6. Impacts from the main geohydrological events in Genoa from 1970, from Faccini et al. (2015, p. 2637) and public funds invested for reducing Bisagno's flood risk. The funds spent on infrastructures amount to about one third of the damages. Elaboration of the author.

The costs of only 2011 flood is clearly higher than the cost of Fereggiano Floodway, estimated in 45 million euros at the moment. A full and extensive knowledge of the risk is necessary also to proceed with realistic ex ante and ex post evaluations: "Basin planning has a cultural problem: technical analyses aren't supported by any robust economic assessment able to evaluate the costs of the projects and the real value of assets (mainly private assets) saved by the same projects. This kind of analyses would have helped in saving money. The EU Flood Directive drives a first change in this approach[138]" (interview with an official of Liguria Land Defence Department). The lack of investment in ex ante evaluations seem particularly paradoxical in Italy where scientific knowledge about nature-related risks is wide: "Italy has a wider knowledge of flood-related risky phenomena compared to what defined and required by EU Flood

[138] Directive 2007/60/EC of the European Parliament and of the Council, 23 October 2007, "on the assessment and management of flood risks". Art. 4 says that "Member States shall, for each river basin district […] undertake a preliminary flood risk assessment" including "an assessment of the potential adverse consequences of future floods for human health, the environment, cultural heritage and economic activity". Flood Risk Management Plans (art. 7) "establish appropriate objectives for the management of flood risks […] focusing on the reduction of potential adverse consequences of flooding for human health, the environment, cultural heritage and economic activity, and […] on non-structural initiatives and/or on the reduction of the likelihood of flooding". The plans "shall take into account […] costs and benefits".

Directive" (interview with an official of Liguria Land Defence Department). The social and political resistance to in-depth cost-benefits analyses applied to Basin Management Plans was due – according to the same interviewee – by the possible economic and political consequences, such as by the difficulties of relocation projects that could be suggested by a serious risks-costs-benefits assessment, or the impact on (already high) insurance costs on assets exposed to high risks areas, that would further discourage private development investments[139].

To build coherent paths of intervention bridging the implementation of short-term actions (for tackling urgent risks) with the definition of long-term adaptation policies (for fostering innovative forms of urban development and management) appears as a critical necessity in contemporary risk-prone cities (Zevenbergen, Veerbeek, Gersonius, & Van Herk, 2008; Rijke, 2014). In Genoa the prevalence of ordinary over-exploitation of natural resources, land and river beds ignoring water vital cycles mirrors the rare preference for proactive approaches. After national reforms in 1998[140], the "*demanio idrico*" (water courses of state property) was managed by Regions (DLgs. no. 112/1998, Art. 86) (DLgs. 112, 1998): Liguria Region carried out an investigation revealing more than 300 buildings realised *inside* fluvial areas, including dozens of public buildings (affirmed by an interviewee from Liguria Land Defence Department and reported also by press (Imarisio, 2014). As summarised by an interviewee from Liguria Region Land Defence Department: "The technical-political gap (referring to the gaps between the scientific knowledge about Genoa's risks and the political strategies put in place) was enormous[141], but it is slowing changing because local authorities are now more responsible for these topics" nevertheless the still evident "political resistance to delocalization and displacements". And again: "we still receive pleas from local public authorities, such as mayors, for allowing building narrowly along covered streams – notwithstanding the current regulations – because a covered riverbed is considered *safe*"[142] and added: "If we would have respected the Royal Decree no. 523 (issued in 1904) which imposed 10 meters distance from river banks for allowing new constructions, maybe we wouldn't need Basin Management Plans".
Liguria Regional Law no. 41 (2014) modified two pre-existing regional laws about building activities and planning fees, generating a special budget for hydraulic works and recognising them a stronger normative value: "works of hydraulic and hydrogeological reorganisation for the safety of urban areas" are now defined as "primary urbanization facilities" (LR. Liguria 25, 1995, art.3). Moreover, in case of non-ordinary building activities[143], developers have to pay an extraordinary contribution to the municipality and the use of these extra fees is bound in the municipal budget for the implementation of projects about: hydraulic or hydrogeological safety; primary or secondary urbanization facilities; public services and public housing (LR. Liguria 16, 2008, art.38). Some applications in Genoa have been already analysed according to the new directive, according to interviewees.

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[139] The problem of displacement of the land values and the difficulties in insuring private assets against floods has been confirmed also by the Genoese professor of planning interviewed, and was used by Greenpeace Italy in a campaign against Generali Insurance Company in April 2018 (https://www.youtube.com/watch?v=hStF162Vlus&feature=youtu.be).

[140] "Bassanini reforms" by the name of the Minister that fostered the new set of laws.

[141] The position of the interviewee described many of the challenges in the science-policy interface explored in §Ch.1.3, 1.4.

[142] Also a professor from Genoa University confirmed the widespread tendency of justifying risky building interventions with hydraulic borderline favourable computations.

[143] Projects needing variations to the town plan or special building permits

Accumulated delay, windows of opportunity, and technical-political gaps: "as it was, where it was"?

The ongoing interventions in Bisagno basin described in the previous paragraph (§Ch.4.3) are an exemplar case of "accumulated delay" in risk reduction activities, where interventions and policies run behind disasters (§Ch.2.1): the remake of Bisagno's coverage and the realization of the underground floodways ground their roots in the studies that followed the catastrophic 1970 flood, and the actual design of the two projects date back to the late 1990s-early 2000s after the introduction of Law L. 267 (1998) struggling to be implemented because of lack of economic resources on the one hand, and breaks due to judicial inquiries on the other hand. Genoa Province and Municipality investments in design activities for reducing flood risk were not wasted: paradoxically enough, the projects for Bisagno and Fereggiano partially or never implemented acted as a "latent capital" – nevertheless updated in terms of technological standards – in the hands of the local authorities to fully exploit the window of opportunity of ItaliaSicura 2015 funds (§Ch.3.2). While a new policy process – and its related funds opportunities – opens up, the outcomes of the previous policy process still need to be implemented and managed.
As told by an interviewee member of the same Council, the City Council that took office in 2012 was determined to give a prime attention to the flood risk, and involved the Chief Officials of Public Works Sector and Hydraulic Works for applying to the "National Plan for Cities" issued by the Ministry for Infrastructures in 2012: the projects for Bisagno area were the preferred candidates because of the availability of studies and designs already on the table, ready to be reviewed and updated. Genoa's projects were already partially funded, grounded on extended design activities and research, object of positive evaluations and agreements between the many authorities involved (as the National Council of Public Works, Liguria Region, Genoa Province and Municipality): this specific status, together with the documented extreme flood risk in the city, was indeed the lever that let Genoa's proposals obtain quickly the large funds aforementioned, among the highest in all Italy (confirming for inverse symmetry the problem of the chronic lack of risk reduction projects in Italy, discussed in §Ch.3.2)
Pre-2011 and post-2011 risk reduction projects differ only in terms of *main actors* involved in designing and promoting the strategy, since the Province's competences have been re-assigned to the Region and the Mission Structure ItaliaSicura entered strongly in the funding process: *interinstitutional agreements* still are the normative framework for defining and develop the strategy, but now involving directly the Region President as Delegated Special Commissioner for hydrogeological risks. The *technical approach* didn't change since the very early stage studies carried on in the 1990s: it is still based mainly on "flood control" made possible by the upgrade of Bisagno coverage and the channelled underground floodways for reducing Bisagno and Fereggiano's peak flows – associated with ordinary maintenance of river beds and river banks. As before 2011 flood, the *funding scheme* is based on special funds from multiple sources, as the Colombiadi event or OPCM no. 3344/2004 before the flood, and the "National Plan for Cities" of the Ministry for Infrastructures and Transports or the "Plan for flood risk reduction in Metropolitan Areas" by ItaliaSicura Mission Structure: the debt capacity of municipalities[144] and regions is currently so low that national or European funds are becoming the essential financing sources for this kind of interventions in Italian municipalities.

[144] For instance, Genoa's debt capacity is about 6-7 million euros each year, according to an Official of Genoa Municipality.

Concluding, even if the Italian mantra “as it was, where it was” (“com’era dov’era”) is used in post-earthquake contexts, it seems to apply quite well also to Genoa’s case.

Available knowledge about Genoa spatial characteristics and flood risk is so valuable to allowing the evaluation of very accurate “what if scenarios” and vulnerability patterns in case of flood: university researchers in Genoa can model floods, vulnerabilities and impacts in the city with impressive accuracy. Although, design solutions are bounded to current adequate pluviometry parameters and return periods that are inaccurate in this non-stationary climate. Indeed, glaciation tends to tone down harsh weather harshness, while warming amplifies climatic inclemency (Rosso, 2014, p. 24). Bisagno is a clear example of this uncertainty: it flooded three times in 44 years with return time T estimated as ≈100 years, 30 years and 90 years, demonstrating that evidently these parameters are not suitable anymore. Actually, different researchers in hydraulic engineers suggested in interviews and informal conversations with the author the necessity of upgrading the norms that regulate the design of hydraulic works imposing performances be able to resist to flood with return time T=200 years (such parameter derives from accumulated technical, academic praxis laws, regulations as L. 365 (2000). In a changing climate, such parameters risk to lose accuracy; in the light of both the large knowledge available aforementioned, and “flood management concept” as described by UE Flood Directive – which goes beyond the ambiguous concept of “flood safety” –, parameters could be correlated to expected *impacts* and not to expected *peak flows*. Works could be designed to resist to smaller return times (e.g. T=50 years) while integrated with secondary measures in a planned strategy (e.g. water plazas, flood-proof building techniques, landscape design, etc): this could allow distinctive multidisciplinary interventions, augmenting city resilience in an uncertain climate, while “we still design as fifty years ago” (interview). Genoa’s future is related to the city ability to invest in its resilience and reduce impasses and delays in the implementation of structural and non-structural risk reduction interventions, vital not only for its population safety, but also for the economic attractiveness of the city.

Interviews – Chapter 4

Associate Professor of Urban Planning at Genoa University (Department of Architecture and Design)	Faculty of Architecture, Genoa - 29th May 2017
Director of the Sector “Territory Protection” at Liguria Region	“Territory Protection” Regional Offices, Genoa - 30th May 2017
President of CIMA Research Foundation, Researcher of Hydraulic Engineering at Genoa University (Department of Informatics, Bioengineering, Robotics and Systems Engineering)	CIMA Foundation, Savona University Campus - 26th September 2017
City Council Member for Public Works and Civil Protection	Genoa - 27th September 2017
Associate Professor of Physical Geography and Geomorphology at Genoa University (Department of Architecture and Design)	Faculty of Architecture, Genoa - 28th September 2017
Researcher (A.Palla) and Associate Professo (I. Gnecco) of Hydraulic Engineering at Genoa University (Department of Civil, Chemical and Environmental Engineering)	Faculty of Engineering, Genoa - 28th September 2017
Official of “Environmental Planning” sector at Genoa Municipality	“Urban Planning” Municipal Offices, Genoa - 28th September 2017
Director of the Sector “Hydraulic Works” at Genoa Municipality, manager in charge of the procedures for Bisagno’s risk reduction	“Hydraulic Works” Municipal Offices, Genoa - 29th September 2017

CHAPTER 5

L'Aquila and the Earthquake

Figure 73. Mural painted for L'Aquila earthquake in via Prenestina, Rome. Picture by the author.

5.1 A HISTORY OF RECONSTRUCTIONS (AND PLANNING EFFORTS)

The seismic risk

Abruzzo Region (Central Italy) is characterized by a frequent and strong seismic activity, documented since the XIV century, due to the collision between the African and Eurasian plates which shaped Italy's peculiar morphology[145]. L'Aquila is Abruzzo's capital city and is located in the central part of the Apennine chain (≈720 metres above sea level) and can be considered an "administrative city" (OECD, 2013, p. 57): L'Aquila's economic base is mainly distributed around the tertiary sector (public and private services, 65%) and the industrial sector (31%, mainly micro-firms); agriculture plays a minor role (3,8%) (Calafati, 2012; OECD, 2013). The historical centre of L'Aquila always had a great symbolic, social, functional and economic importance in the area, hosting about 10.000 inhabitants and at least 6.000 university students (Frisch, 2009, p. 30; Calafati, 2012, p. 30) at the beginning of the 2000s. The municipality counts about 67.000 inhabitants according to 2011 national census, spread between the main urban centre and other 59 hamlets ("*frazioni*")[146] along the Aterno river valley and surrounding slopes. Indeed, the municipal territory is very vast: about 474 sq.km., the 10th largest municipality in Italy[147]. Such peculiar "urban sprawl" dates back to the foundation of the city itself. Sabini, Vestini and later Romans inhabited Aterno river valley until Early Middle Ages; ancient settlements progressively disappeared, until the growing of fragmented feudal dominations after year 1000. The city of L'Aquila was founded in 1254 by Conrad IV of Swabia – with antifeudal purposes – along the northern areas of the Kingdom of Sicily. After years of fights among the Kingdom of Sicily, the State of the Church and separatist movements, the city was destroyed and actually re-founded in late 1260s. The establishment of the city gathered inhabitants from numerous settlements spread in the surrounding territory; the migratory movements contributed to the physical construction of the new urban fabric, willingly leaving traces of their origins (Alessandro Clementi, 2011). The so-called "Comitatus Aquilanus" was a physical, economic and political system which linked the city, the minor settlements and the rural surroundings: L'Aquila is an ancient example of "Città-Territorio" ("city-territory") (Frisch, 2009, p. 10).

L'Aquila's territory has been severely struck by major earthquakes at least 6 times since 1300 – in 1315 (Moment Magnitude Mw ≈6.7), 1349 (Mw ≈6.5), 1461 (Mw ≈6.5), 1703 (Mw ≈6.7), 1915 (Mw ≈7.0) and 2009 (Mw ≈6.3) (Bazzurro et al., 2009; Rovida et al., 2016) – experiencing wide reconstructions each time (Alessandro Clementi, 2011; Redi, 2011). The earthquake in 1703 was the most destructive, killing hundreds of people in L'Aquila's area[148]: at the beginning of the XX century the shape of the city centre was still linked to the XVIII century post-earthquake design, with large empty spaces inside the medieval walls that will be progressively occupied during the XX century. The expansion of the urban periphery outside the historical centre dates back mainly to post-World War II (Frisch, 2009, pp. 11-12, 17). The last dramatic earthquake happened on 6th April 2009 (Mw ≈6,3), destroying the city centre and numerous *frazioni*, severely damaging also dozens of surrounding municipalities in central and western Abruzzo, killing more than 300 people.

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[145] This region has one of the highest seismic hazard in Italy (Chiarabba et al., 2009).

[146] 2011 Istat national census is available at http://dati-censimentopopolazione.istat.it/Index.aspx

[147] Data from Istat website https://www.istat.it/it/archivio/82599

[148] The estimates of the casualties vary a lot, from 800 people to 2.000 or even 6.000. See Alexander (2013a); Valensise et al. (2017).

Figure 74 and Figure 75 show the seismic hazard in Italy – expressed as Peak Ground Acceleration according to the Italian Seismic classification[149] – highlighting L'Aquila's very high seismic hazard level.

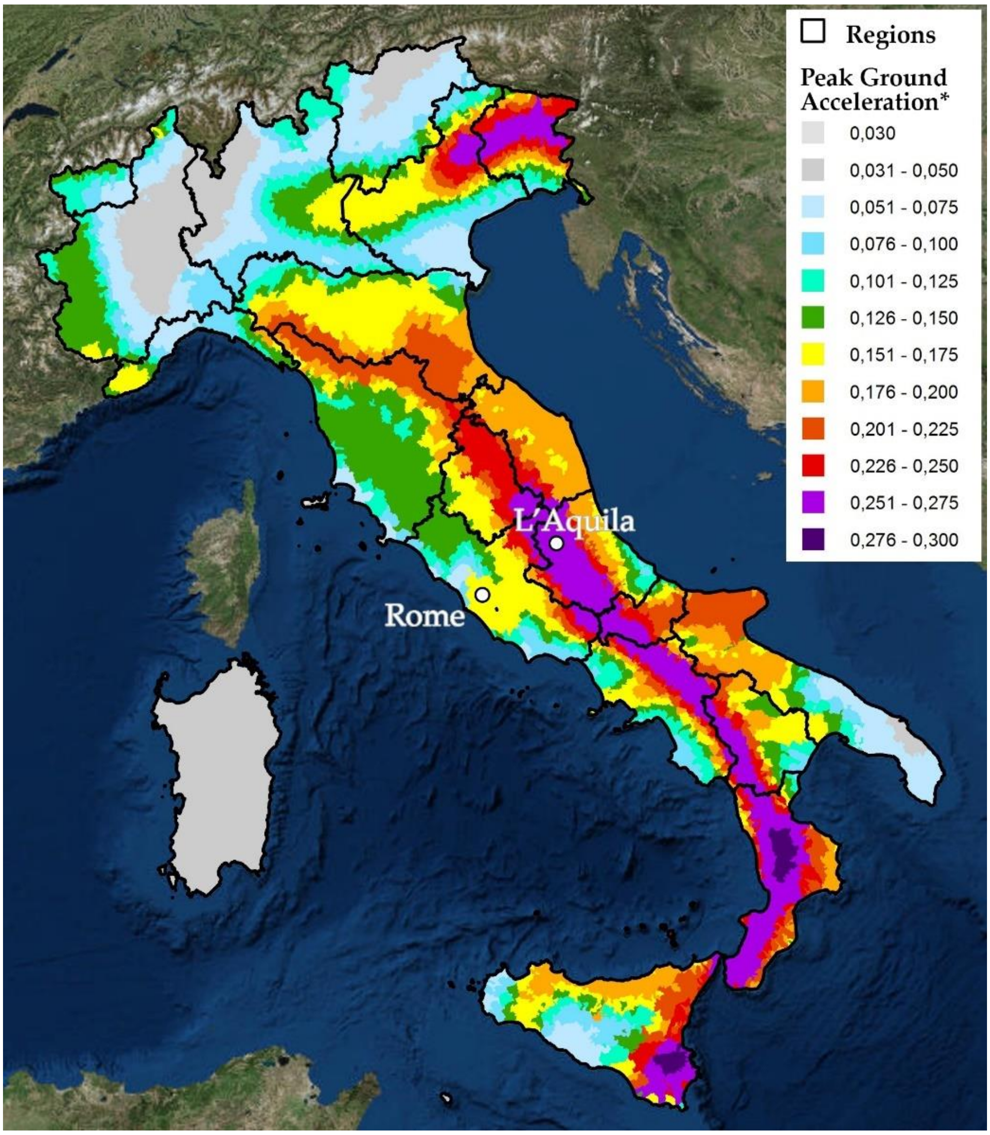

Figure 74. Map of seismic hazard of the national territory, elaborated by the National Institute of Geophysics and Volcanology (2006)[150]. Graphic re-elaboration of the author.

** Value of horizontal acceleration of the soil that is estimated to occur or be exceeded with a probability of 10% in 50 years, assessed on rocky and flat soil, and expressed as a fraction of gravity acceleration (1g = 0.981 cm / s2).*

[149] Areas with "high" or "medium" level of seismic hazard are coded as zones 1, 2, 2A and 2B. See also note 25.

[150] Map available at http://gisportal.istat.it/mapparischi/

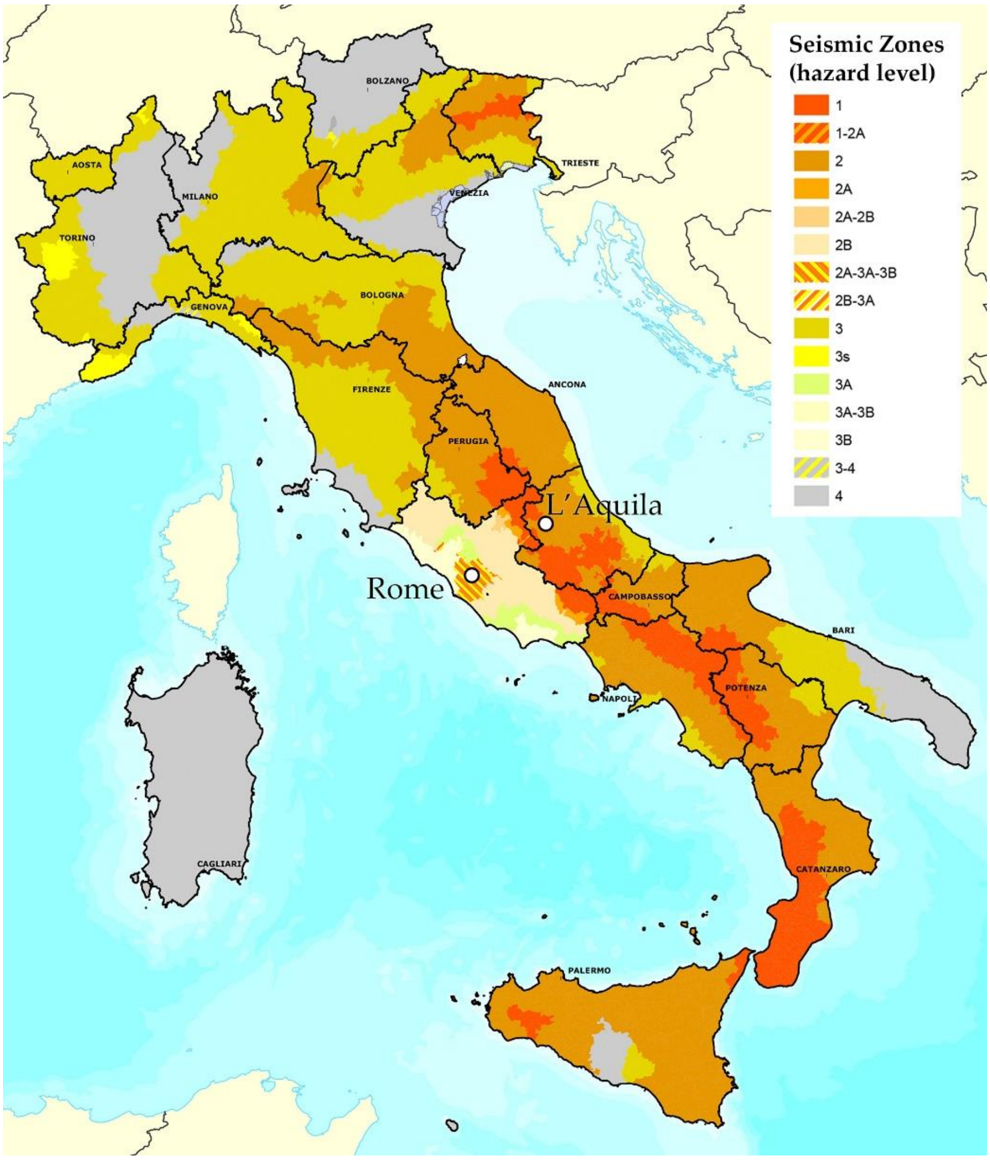

Figure 75. Areas with "high" or "medium" level of seismic hazard are coded as zones 1, 2, 2A and 2B. Italian seismic classification (2015) elaborated by the Department of Civil Protection[151]. Graphic re-elaboration of the author.

The planning scenario

The city of L'Aquila didn't update its town planning in the last 40 years. L'Aquila's last Town Plan – and still currently in force – was adopted in 1975 and approved in 1979[152], sized for about 100.000-120.000 inhabitants, leading to a "fragmented growth of the city and the deterioration of important environmental and landscape resources" (Comune di L'Aquila, 2017, p. 13). The urban development followed mainly a Northwest-Southeast direction (Figure 76), influenced by the massifs on the North and by the realisation of L'Aquila-Rome motorway with two exits on the East and West sides of the city.

[151] Available at www.protezionecivile.gov.it/resources/cms/documents/A3_class20150416_r.pdf

[152] Previous plans were elaborated in 1917-1930 and 1962-1965 (Frisch, 2009, pp. 17-18).

Figure 76. Aerial view of L'Aquila (detail). Google image.

The town plan's indications for the expansion of L'Aquila centre were progressively enacted, while the growth of the hamlets wasn't so massive as anticipated (Frisch, 2009, p. 21) and the population growth was evidently lower than expected[153]. Planning instruments of those years paid limited attention to nature-related risks, as indicated also by an Official of L'Aquila Municipality: "The main urban development in the western area of the city was all along Pettino's fault"[154]. The cultural and normative attention to nature-related risks was still in very early stages also at the national scale in those years[155] (§Ch.3.2). Table 7 summarises the planning scenario.

L'Aquila Planning	1975/79 Town Plan	2001/07 Studies for a new Town Plan **(interrupted)**	2004 Structural Plan **(never approved by the Province)**	2009 Strategic Plan (first drafted version)	earthquake
Regional Planning	1990 Regional Landscape Plan		2004 Studies for the new Regional Landscape Plan **(in progress)**	2008 Plans for Flood Risk (PSDA, **under revision**) and Hydrological Risks (PAI)	

Table 7. Planning instruments and studies at the moment of the earthquake. Elaboration of the author.

In 2001-2007 preliminary studies for a new Town Plan were elaborated by Arch. Francesco

[153] The urban development depicted by the 1970s town plan imagined a city for about 129.000 inhabitants (Comune di L'Aquila, 2017, p. 121).

[154] Pettino's fault was very active in 2009 quake (Basili et al., 2009, p. 21) and the homonymous neighbourhood – commonly called "the neighbourhood on the fault" – was among the most damaged on 6th April (Calandra, 2013, p. 22).

[155] L'Aquila's Building Regulation *("Regolamento Edilizio")* (Comune di L'Aquila, 1972) was enacted in early 1970s, and it is still in force; its anti-seismic standards still quotes the art. 46 of L. 1684 (1962), first Italian law in this field.

Karrer but the role was revoked in 2008 by the new mayor Massimo Cialente[156]. A "General Development Plan" ("*Piano Strutturale*") was approved on 30th January 2004 by the City Council as "guiding tool" for understanding the main territorial systems (environmental, infrastructural, settlement paths) and envisioning a long-term scenario. This plan didn't have a normative role, since this typology of planning act was not acknowledged by national nor regional planning laws (Deliberation of the Municipal Council no. 98, 15th March 2013); its role was weakened also by the missing approval by the Province of L'Aquila (Comune di L'Aquila, 2012, p. 18). Later on, a final proposal for a proper "Strategic Plan" for the city was presented by the Municipal administration on March 2009 (Comune di L'Aquila, 2009), three weeks before the earthquake: the document mentioned the theme of "prevention of seismic events" through the general indication of "measures for managing and prevent natural risks". From the point of view of overriding regional spatial planning, it's important to underline that the Regional Landscape Plan is outdated as well, approved in 1990; the drafting of the new Regional Landscape Plan began in 2004 but still missing a formal adoption. The regional Flood Risk Management Plan (PSDA) and the Hydrogeological Plan for hydrological risks (addressing landslides mainly) (PAI) are more recent – approved in 2008 – but the PSDA needed soon a revision due to the European Floods Directive 2007/60/EC and the consequent national decree DLgs. no. 49/2010 (the Flood Risk Plan for the "Central Apennines" district, which includes Abruzzo territory, was approved in October 2016).

5.2 THE 2009 EARTHQUAKE

A destroyed city, in a Seismic Crater

The territory of L'Aquila experienced an unusual although weak seismic activity since October 2008-January 2009[157], which clearly increased from the last days of March 2009: on 30th March a Mw ≈4,3 quake struck the area and an expert meeting of the "National Commission on Major Risks" (advisory board of the national Civil Protection) was convened the following day, involving also head representatives of the national and local Civil Protection, the mayor of L'Aquila, and other representatives of local administrations; the meeting had the goal to provide an accurate analysis of the ongoing seismicity, from the "scientific and civil protection-related" points of view[158]. On 5th April another intense quake (Mw ≈4,1) was perceived in the

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[156] L'Aquila's recent Mayors: Biagio Tempesta (Forza Italia, centre-right), 1998-2007; Massimo Cialente (Partito Democatrico, centre-left) 2007-2017; Pierluigi Biondi (Forza Italia, centre-right) since 2017.

[157] Different positions about the beginning of L'Aquila's foreshock seismic sequence are available in literature and official reports (e.g.: Papadopoulos, Charalampakis, Fokaefs, & Minadakis, 2010; D'Avolio & Picuti, 2012; Amato & Galadini, 2014).

[158] The activities of the Commission were object of a trial between 2011 and 2015, known as "L'Aquila Trial", that became target of harsh legal, scientific and political debates. On October 2012 seven main functionaries involved in the Commission were convicted for manslaughter: their evaluation of risk was defined "approximate, generic and ineffective", they "failed in their duties of risk assessment, their duties of forecasting and prevention, and their duties of clear, correct, complete information"(Tribunale di L'Aquila & Billi, 2012). As summarized by Alexander (2014a, p. 1160), they were accused for "having given out falsely reassuring information to members of the public". The second appeal, on November 2014, overturned the first verdict of the Court, acquitting six of the seven defendants. The only convicted was Bernardo De Bernardinis as Deputy Director of the National Department of Civil Protection. The Court of Cassation (last degree of the trial) fully upheld the decisions of the judges of the second degree on November 2015. Several documents about the trial are available at https://processoaquila.wordpress.com/. Wide literature is available; among many others (sustaining different positions): Cianciotta and Alessandroni (2013); Alexander (2014a); Amato, Cerase, and Galadini (2015).

area, and five hours later on 6th April 2009 at 3.32 am a Mw ≈6,3 earthquake – whose epicentre was located 5km far from L'Aquila city centre – devasted western Abruzzo. For the first time in Italian history after Messina's earthquake in 1908, an earthquake destroyed a major city, actually a regional capital city. The earthquake left 309 dead and 1.600 injured people, and more than 60.000 inhabitants were displaced[159]. "Seismic Crater" is the definition used to indicate L'Aquila and other 57 municipalities that experienced a quake with an intensity value equal or higher than VI level of Mercalli intensity scale[160] (and therefore considerably damaged) (Figure 85).
In 2008 around 144.000 inhabitants (about half of which in L'Aquila) lived in this large (about 2.400 square kilometres) and polycentric area; a figure that declined to 138.000 inhabitants – with still half of it living in L'Aquila's municipality – according to the last National census available (2011). The Crater is composed of numerous scattered settlements and villages, mostly tiny in size and population: out of 57 municipalities, only 10 (L'Aquila included) have more than 2.000 inhabitants, and mainly with an ageing population. The social and economic fragility of this territory is also testified by the fact that 44 municipalities (77% of the Crater) are indeed labelled as "inner areas" according to the Italian "National Strategy for Inner Areas" (SNAI): "inner areas" are peripheral villages and rural areas that need to refer to quite distant major "urban" systems for having access to basic public services such as health and secondary education. Because of this inadequate access to collective services, they are recognised as marginalised and disadvantaged areas of the country. SNAI describes inner areas as generally stressed by demographic decline, scarcity of job opportunities, hydrogeological instability, deterioration of the cultural and landscape heritage[161].

Early damage evaluations (as reported by the Civil Protection one year after the earthquake[162]) revealed that, out of 73.000 damaged buildings inspected, 32% of private buildings, 21% of public buildings and 53% of cultural heritage were classified as "completely inhabitable". Open data tracking the procedures for granting contributions for private buildings in the entire Crater (updated on February 2018, including also extra-Crater damages[163]) show that only 44% of fund requests involved minor interventions on "habitable"

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[159] Data from Italian Civil Protection: http://www.protezionecivile.gov.it/jcms/it/emergenza_abruzzo_unanno.wp;jsessionid=335F9CD5EB7A570D6D8C0F18792EDA3E.worker3) confirmed by academic literature (Chiarabba et al., 2009; Dell'Osso et al., 2011). Official data referred to August 2009 indicate ≈49.000 "assisted inhabitants": 20.000 in camps, 20.000 in hotels, 9.000 in private houses (GSSI data from http://opendataricostruzione.gssi.it/emergenza/tendopoli/).

[160] According to macro-seismic surveys carried out by the Department of Civil Protection with the National Institute for Geophysics and Volcanology (Commissario delegato ai sensi del decreto del presidente del consiglio dei ministri del 6 aprile 2009, 2009a, 2009c).

[161] The spatial-functional organisation of all Italy can be described as a "polycentric structure", based on medium-large cities (mainly located along coastal areas and in the northern wide flatlands) which host the majority of the population and act as hubs for primary services; widespread networks of little towns, villages and rural areas (mainly located in hilly or mountainous zones) gravitate around these "urban" systems, defined "Inner Areas" by SNAI (Barca, Casavola, & Lucatelli, 2014, p. 14). Nevertheless constant marginalisation and demographic decline, around one-quarter of Italy's population lives in inner areas: SNAI is the specific long-term policy for their economic and social redevelopment, and was launched by the Italian Government in autumn 2012 (operative since 2014). SNAI didn't paid the adequate attention to nature-related risks, as affirmed by one of the main Strategy Coordinators at the "Biennale dello Spazio Pubblico" held in Roma Tre University on May 2017, during the session "Disasters and reconstruction of the public space". For further readings about the Crater's reconstruction, see the author's 2016 article (Di Giovanni, 2016b).

[162] http://www.protezionecivile.gov.it/jcms/en/emergenza_abruzzo_unanno.wp?request_locale=en

[163] Cases of minor sporadic damages induced by the earthquake in municipalities non-included in the Seismic Crater.

private buildings, while 31% concern “temporarily or partially inhabitable buildings” and 23% “completely inhabitable buildings”[164].

L’Aquila suffered the worst damages, as shown in Figure 77 and Figure 79: 36% of private buildings are coded as “inhabitable” (“E”), and ≈7.000 are resident houses. Data about the rest of the Crater (excluding the city of L’Aquila, see Figure 78 and Figure 80) enlighten the scattered effects of the earthquake and the diversity of the territory: damages have been milder compared to L’Aquila (62% of procedures are referred to “habitable” buildings “A”) and the percentage of houses not used as primary residence (shortly, “non-resident houses”: holiday houses, rented houses, shared areas) dispersed along the Seismic Crater is clearly higher.

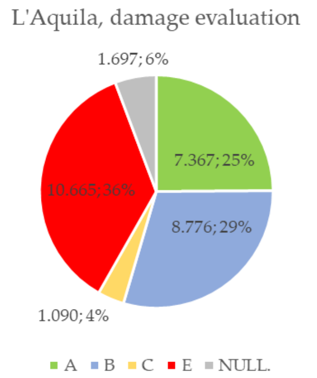


Figure 77. Habitability of private buildings in L’Aquila City.

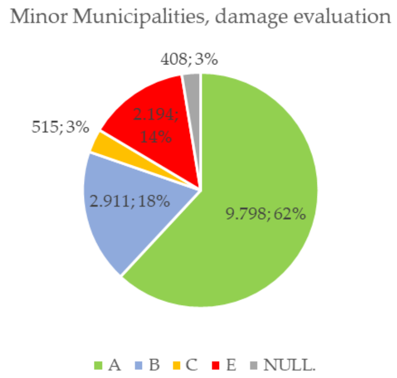


Figure 78. Habitability of private buildings in the Minor Municipalities.

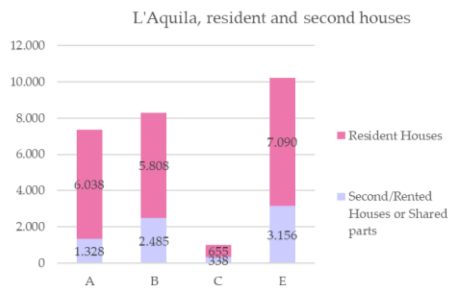


Figure 79. Habitability of resident and non-resident houses in L’Aquila City.

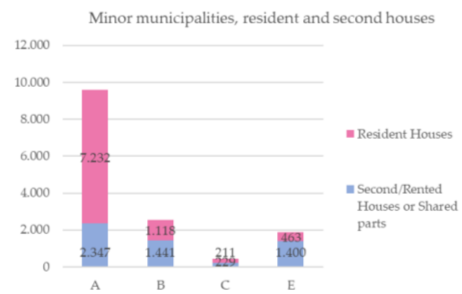


Figure 80. Habitability of resident and non-resident houses in Minor Municipalities.

Habitability status according to AeDES Forms (first level assessment about damage and usability for ordinary buildings in post-earthquake scenarios):

A: habitable buildings

B: temporarily inhabitable buildings

C: partially inhabitable buildings

E: inhabitable buildings for geotechnical or structural risks

Data elaborated by the author from official open data (see footnote 164), referred to procedures for granting contributions updated on February 2018

[164] http://opendataricostruzione.gssi.it/ricostruzione-privata/

The historical centre, vital heart of the city, was severely and widely damaged by the quake, as shown in Table 8: the 65% of habitability status refer to inhabitable buildings (E).

L'Aquila's Habitability status	**A**	**B**	**C**	**D**	**E**	**F**	**Total**
L'Aquila historical centre	151 (14%)	140 (13%)	13 (1%)	-	**689 (65%)**	70 (7%)	1.063
Hamlets' (*frazioni*) historical centres	1.921 (37%)	681 (13%)	123 (2%)	4 (0,1%)	**2.208 (42%)**	287 (6%)	5.224
Remaining areas	7.544 (54%)	2.749 (20%)	357 (3%)	18 (0,1%)	3.125 (22%)	187 (1%)	13.980
Total	9.616 (47%)	3.570 (18%)	493 (2%)	22 (0,1%)	6.022 (30%)	544 (3%)	20.267

Table 8. Habitability in L'Aquila Municipality, updated to October 2011.

A: habitable buildings; B: temporarily inhabitable buildings; C: partially inhabitable buildings; D: temporarily inhabitable buildings to be re-examined; E: inhabitable buildings for geotechnical or structural risks; F: inhabitable buildings for severe external risk. Elaboration of the author from L'Aquila Reconstruction Plan (Comune di L'Aquila, 2011a, p. 110).

The emergency

The "emergency phase" started the day of the earthquake declared by Decree of the President of the Council of Ministries Silvio Berlusconi, and Guido Bertolaso, Director of the National Department of Civil Protection, was nominated Extraordinary Delegate Commissioner for Emergency Management. Due to the massive damages, the historical centre of the city was immediately declared inaccessible, labelled as "red zone" and put under military control, prohibiting any access in order to guarantee the public safety, to allow intervention on the building fabrics[165]. While people were rescued and hosted in makeshift shelters and camps, L. 77 (2009, art.2) and the Executive Decree of the President of the Council of Ministers OPCM. 3790 (2009, art.7) addressed the topic of post-disaster transitional dwellings that were realised according to two prefabricated models: the MAP project and the CASE project. The MAP project (*Moduli Abitativi Provvisori*, "Temporary Housing Models") consisted in small wooden buildings (1-2 floors) for temporary staying of inhabitants whose homes were inhabitable or located in restricted areas (meant to be demolished henceforward). MAP dwellings were located both in L'Aquila municipality (28 sites, ≈1300 units) and in the minor municipalities of the Crater (≈2260 units)[166],[167]. The same Law no.77 introduced the CASE project (*Complessi Antisismici Sostenibili ed Ecocompatibili,* "Sustainable and Ecology-Compatible Anti-Seismic Complex"): this program was conceived to provide wider and longer-term accommodations thanks to 185 new buildings (2-3 floors, ≈4.450 flats) mainly constructed of wood but built upon concrete bases isolated against seismic activity. They were

[165] The red zone was defined by the Municipal Ordinances no. 6 and 73 in April 2009; portions of the urban centre were slowly partially re-opened to the citizens since Summer 2010 (Municipal Ordinance 627, July 2010), also as answer to wide protests of inhabitants and associations against the prolonged inaccessibility of the area, known as "wheelbarrows riots".

[166] Data from National Civil Protection website http://www.protezionecivile.gov.it/jcms/it/view_dossier.wp;jsessionid=7F863F18B38342B319B5895369D16D2D.worker3?contentId=DOS322

[167] On 1st October 2013 data about the city of L'Aquila report 2.248 people hosted in MAP units.

distributed through 19 sites exclusively in the municipality of L'Aquila, hosting about 15.000 people whose homes were destroyed or deemed inhabitable[168]. These mini-settlements, full-equipped with proper infrastructures and used for temporary housing during the emergency phase, were declared to be re-usable for other uses in future, mainly for accommodating university students, young couples, for the need of the city housing policies, and so on[169]. The location of CASE areas was determined with a series of decrees of the Commissioner between May 2009 and January 2010[170], in agreement with the Mayor of L'Aquila and the President of Abruzzo Region Giovanni Chiodi[171] (Frisch, 2009, pp. 32-33). The choice of the areas had to be guided by the proximity to inhabitants' original neighbourhoods[172], the integration with pre-existing settlements, seismic and hydrogeologic security, environmental and landscape sustainability, accessibility. The choosing of these areas implied the declaration of public utility and urgency of the works, allowing the emergency occupation of the areas and their expropriation, therefore designing an instant variation of the existing urban planning instruments (Commissario delegato ai sensi del decreto del presidente del consiglio dei ministri del 6 aprile 2009, 2009b). In L'Aquila, about 250 hectares were used for the setting-up of temporary accommodation (MAP, MUSP[173] and CASE) (Comune di L'Aquila, 2014, p. 380) mostly located in greenfield sites (Fontana, 2017). The construction of MAP and CASE projects cost respectively € 238.107.000 and € 814.000.000 according to official opendata, plus about € 65.760.000 for expropriations[174]. The guidelines stated in the Decree weren't applied in relation to the final location of the areas, the allocation of inhabitants, or environmental preservation[175] as shown by Figure 81, Figure 82, Figure 83.

[168] Data from National Civil Protection website:
http://www.protezionecivile.gov.it/jcms/it/view_dossier.wp?contentId=DOS274

[169] The Municipality of L'Aquila in in charge of the management of CASE and MAP projects since 31st March 2010. The reuses of the temporary housing were defined in a Deliberation of the City Council in 2011 (no. 172, 29th December), quoted also in the General Report of the new town plan (see further).

[170] Data from National Civil Protection website
http://www.protezionecivile.gov.it/jcms/it/view_dossier.wp?contentId=DOS282

[171] Giovanni Chiodi (Il Popolo della Libertà, centre-right) was elected on December 2008.

[172] Calandra's works about L'Aquila earthquake label as "L'Aquila diaspora" the sprawl induced by the disaster, also underlying how this criterion was not respected. See Figure 83.

[173] MUSP (Modulo ad Uso Scolastico Provvisorio) stands for "Provisional School Use Module".

[174] Open data available at http://opendataricostruzione.gssi.it/emergenza/#. Costs tracked in the National Civil Protection website are quite equivalent (http://www.protezionecivile.gov.it/jcms/it/view_dossier.wp?contentId=DOS37387).

[175] Many criticisms arose about the strategy adopted for temporary shelter in Abruzzo from planning, economic and social perspectives. For further readings, see Frisch (2009); Erbani (2010); Calandra (2012b); Alexander (2013a).

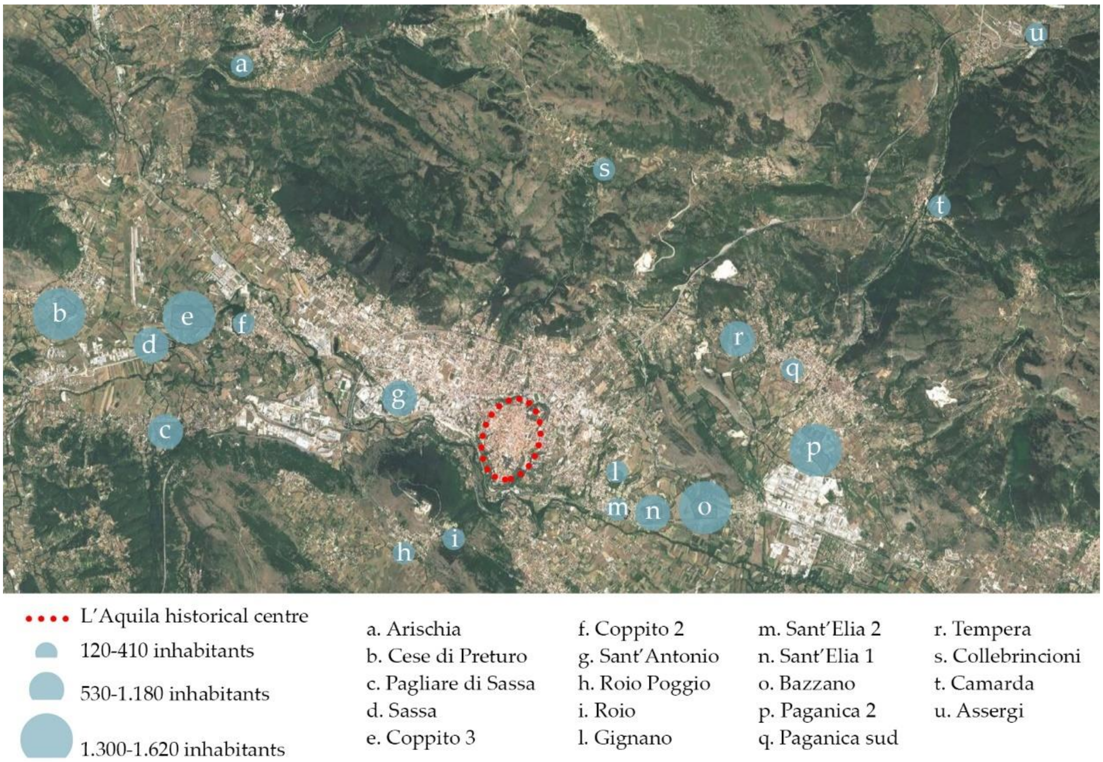


Figure 81. Location of CASE project L'Aquila Municipality. Elaboration of the author from http://opendataricostruzione.gssi.it/emergenza/case and Calandra (2012b, p. 317)

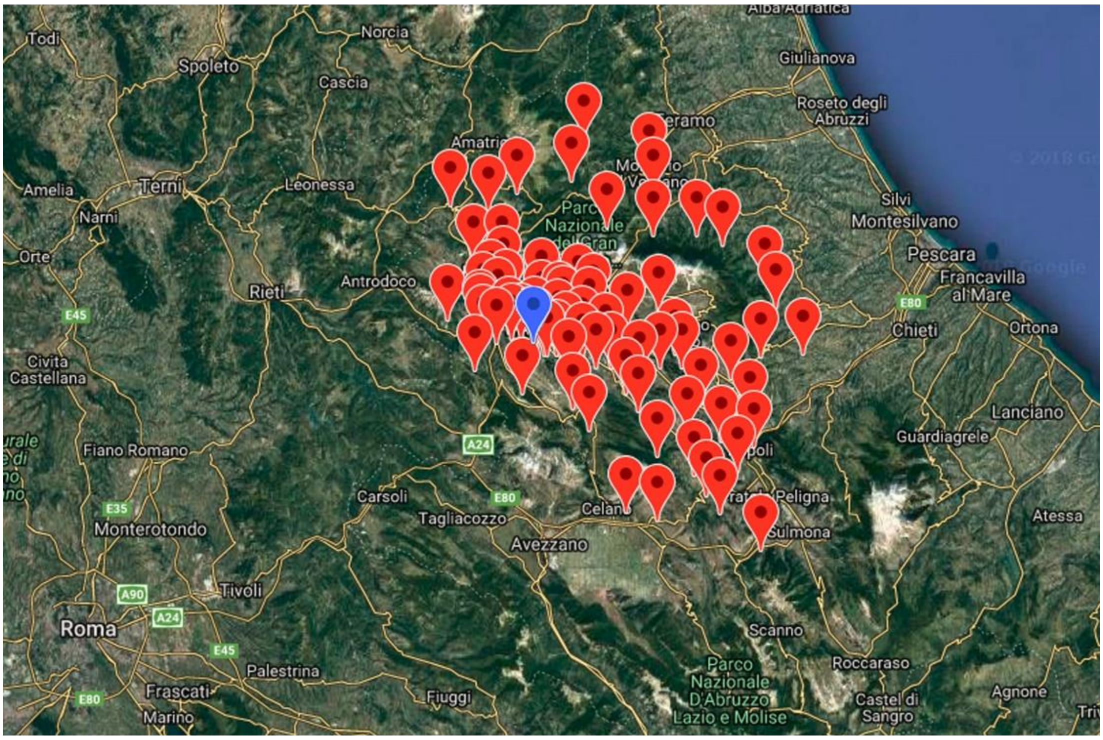


Figure 82. Location of Map projects in Abruzzo. In blue, L'Aquila city.
Map from http://opendataricostruzione.gssi.it/emergenza/map//

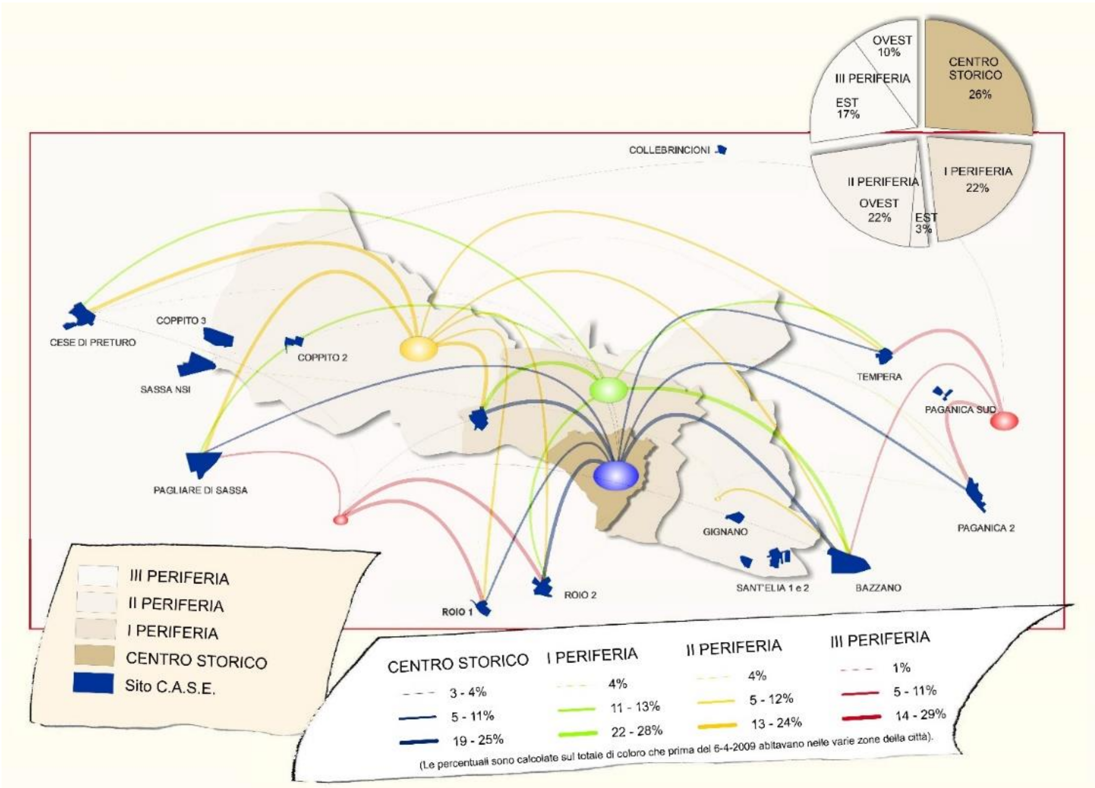


Figure 83. L'Aquila "diaspora" as defined by Calandra (2012b, p. 327). The pie chart shows the provenance of the inhabitants of CASE project; the map illustrates the "diaspora" from the various areas of the city towards CASE sites.

On June 1st 2010 (14 months after the disaster), around 49.000 people were assisted in their accommodation needs, mainly through the two temporary housing programs (18.600 people) or benefitting a public subsidy to find an alternative housing solution autonomously (26.000 inhabitants chose this option); around 4.300 people were still hosted in hotels or barracks (Commissario delegato per la ricostruzione Presidente della Regione Abruzzo - Struttura Tecnica di Missione, 2010b). Data referred to December 2017 highlight that about 12.000 inhabitants were still beneficiaries of public assistance for housing needs (≈10.200 in L'Aquila and ≈4.800 in other municipalities) (Struttura di Missione per il coordinamento dei processi di ricostruzione e di sviluppo nei territori colpiti dal sisma del 6 aprile 2009, 2018, p. 4).

5.3 SETTING THE STAGE FOR THE RECONSTRUCTION: THE CITY AND REGIONAL SCALES

To merge the physical recovery of the built environment with long-term territorial development was indicated as the overall goal to achieve with this reconstruction, clearly stated by L. 77 (2009), by the Decree of the Commissioner DCDR. 3 (2010) and by L. 134 (2012): these enactments set the bases for the first legislative framework to guide the rebuilding process and the coordination of multiple initiatives and institutions in the Crater.

A new institutional framework

New bodies and offices were introduced with the aim of coordinating the extraordinary flows of resources involved within the two phases, bridging local administrations and national ones. As shown below in Figure 84, during the emergency phase a Technical Mission Structure *(Struttura Tecnica di Missione)* – established on December 2009 depending directly on the Presidency of the Council of Ministers – was the temporary emergency institution with the role to control the use of public funds and coordinate works and plans for the Crater bridging local levels with the national authorities (who had a predominant leading role, especially in the first years). According to Law no. 77, the Crater's municipalities (in agreement with the Region's and Provinces' Presidents) were asked to define strategic guidelines for municipal (re)planning to foster socio-economic recovery and urban redevelopment, ensuring a harmonious reconstruction of urban fabrics (Art. 2, 12-bis).

	Emergency Phase 6th April 2009-31st August 2012		**Ordinary Administration** from 1st September 2012	
National Level	Presidency of the Council of Ministers[176]; Department of Civil Protection (Commissioner until 2010)		Presidency of the Council of Ministers[176]; New Mission Structure	
Intermediary Level	President of Abruzzo Region G. Chiodi (as Commissioner from 2010); Technical Mission Structure		Special Office for the Reconstruction of L'Aquila City (USRA)	Special Office for the Reconstruction of Minor Municipalities (USRC)
	9 Homogenous Areas			
Local Level	HA. 1 L'Aquila City	HA. 2 - 9 Minor Municipalities, with 1 representative for each HA gathering in a Mayors Union, and 1 Delegate for all the Crater		HA. 2 - 9 Minor Municipalities, with: 1 Local Technical Office (UTR) and 1 representative for each HA gathering in a Mayors' Union, with common Delegates for all the Crater

Figure 84. Governance Framework for the emergency and ordinary phases

Decree 3 widened and reinforced the general aims of the reconstruction process calling for coordination of multiple initiatives to envision inter-municipal large-scale scenarios and to reinforce mutual relations among L'Aquila and the neighbouring settlements. Art. 1 states: "in order to "ensure the social and economic recovery, the housing redevelopment and a harmonic reconstruction of urban settlements and productive facilities in the areas affected by the earthquake, the general criteria for the reconstruction process promote the coordination and integration of initiatives fostering a territorial and inter-municipal vision". More pragmatically, the "Homogeneous Area" (HA) has been framed as optimal territorial and administrative entity to coordinate and synergistically address inter-municipality reconstruction. Excluding L'Aquila (HA 1), other 56 municipalities of the Crater have been aggregated in eight HAs through volunteer agreements among mayors, with a "leading municipality" for each HA and a common Coordinator for all of them (Figure 84, Figure 85).

[176] Presidents of the Council of Ministries since the earthquake: 2008-2011: S. Berlusconi (Forza Italia, centre-right); 2011-2013: M. Monti (independent experts cabinet); 2013-2014: E. Letta (Partito Democratico, centre-left); 2014-2016: M. Renzi (Partito Democratico, centre-left); 2016-2018: P. Gentiloni (Partito Democratico, centre-left); since 2018: G. Conte (Movimento 5 Stelle/Lega agreement, centre-right).

HAs represented a form of “temporary clustering” of municipalities with no normative authority on single municipalities as institutional bodies.

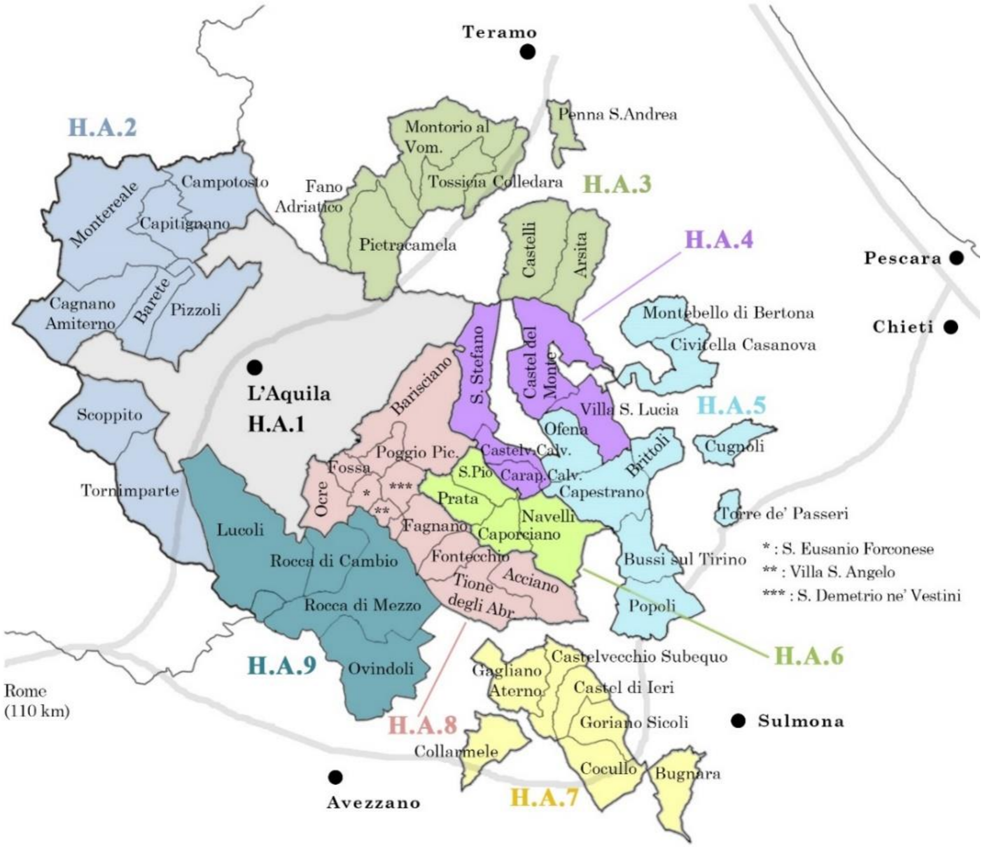


Figure 85. The 2009 Seismic Crater and the organization in Homogenous Areas (Di Giovanni, 2016b, p. 123)

An innovative governance model was gradually built and based on the collaboration among central control structures and local authorities: the growing relevance of local institutions emerged more clearly with the return to “ordinary administration” in 2012. Law no. 134/2012 (chapt. X) closed the emergency phase in September 2012 (Figure 84): the return to “ordinary” public administration introduced two brand-new “Special Offices for the Reconstruction” (USRA office for the city of L’Aquila; USRC office located in Fossa, coordinating all the minor municipalities of the crater, and extra-crater earthquake-related procedures) (OPCM. 4013, 2012); the Special Offices co-operated with the “Department for the development of territorial economies” (DISET)[177] of the Presidency of the Council of Ministers, until a specialized “New Mission Structure for the coordination of the reconstruction and development processes of the territories hit by the earthquake of 6 April 2009” was established in June 2014[178]. On the one hand, USRA and USRC provide technical assistance for public and private reconstruction and maintain the financial monitoring and implementation of interventions, cooperating directly with central institutions. On the other hand, USRC office is also in charge of coordination of 8 dedicated “Technical Offices” (UTR)

[177] DISET department was re-defined “Department for planning and coordination of economic policies” (DIPE) in 2016.

[178] The Mission Structure was established by the Decree DPCM. 1 giugno (2014).

(OPCM. 4013, 2012) settled in each Homogeneous Area in order to accelerate and simplify the examination of funding requests for the reconstruction[179].

Planning after the disaster #1: the Reconstruction Plans and the Causality Nexus

Law no. 77/2009 defined the "Reconstruction Plans" as extra-ordinary planning instruments[180] for guiding the reconstruction process in the historical centres in the whole Crater, according to the following strategic goals (Art. 14, 5-bis):

1. To ensure social and economic recovery
2. To promote urban redevelopment
3. To facilitate the return of inhabitants at home

These aims were reinforced by the Decree no. 3/2010 (Art. 5) and confirmed later on in 2012 by Law no. 134 (Art. 67 quarter). The Plans act within specific "perimeters" *("perimetrazioni",* Decree 3, art. 1) defined after the earthquake with the aim of identifying parts of the towns with peculiar historical and landscape values, and largely damaged. Generally, the perimeters overlap with the "historical centres" as defined by pre-existing ordinary town plans. The purpose of establishing these perimeters was to ensure a coherent and unitary planning for valuable portions of the settlements. Outside these perimeters, the reconstruction has followed different regulations, allowing case-by-case reconstruction and relying on running regulations and planning (when existing), without requiring new extensive plans.

Nevertheless the aggregation in HAs, every municipality could assign the design of its Reconstruction Plan autonomously. The HAs no. 4, 5 and 9 are the only cases in which Plans have been designed coherently by the same researchers for almost all the HA's municipalities (university research teams from University of Padua for HA4[181], University of Chieti Pescara for HA5[182] and University of Rome Sapienza for HA9[183]). A similar fragmentation occurred even in consultancies for the Plans of three *frazioni* of L'Aquila (Onna, Tempera and Bagno. Comune di L'Aquila, 2011c, pp. 31-36).

Investigations into the Plans of HAs 4, 5 and 9 were published by the author in 2016 and 2017 (Di Giovanni, 2016b; Di Giovanni & Chelleri, 2017). The prevalent and fundamental components of the Plans are prescriptive indications for the physical reconstruction of historical centres, therefore to answer the *third* goal of the laws: to facilitate the return of inhabitants in an anti-seismic built heritage. Also L'Aquila's Reconstruction Plan – that was adopted and approved between February and August 2012 – openly stated this aspect: "the facilitation of the return of the population in the houses affected by the earthquake, placed among the objectives of the Law no. 77/2009, is the main strategic guideline of the reconstruction, and that it should be pursued as *in priority by encouraging, where possible,*

[179] The personnel working in USRA, USRC ad UTR Offices was selected and hired through a national-scale competition between 2012 and 2013.

[180] Latterly, Law no.134 (Art. 67-quinquies) confer the reconstruction plans a "strategic nature", aiming at quantifying the financial needs for the reconstruction, regulating implementation and schedule of interventions in the historical centres. If validated by the Province, the Reconstruction Plans have a "normative nature" instead, integrating and replacing pre-existing planning instruments. Out of 55 Minor Municipalities (one town didn't define the Plan), only 8 preferred a strategic plan (http://www.usrc.it/attivita/piani-di-ricostruzione/i-piani-di-ricostruzione). The Municipality of L'Aquila in its Plan openly criticized the interpretation of the Reconstruction Plans as regulatory town planning instruments (Comune di L'Aquila, 2011a, pp. 81-82).

[181] Municipalities: Castelvecchio Calvisio, Castel del Monte, S. Stefano di Sessanio, Villa S. Lucia degli Abruzzi

[182] Municipalities: Brittoli, Bussi sul Tirino, Civitella Casanova, Cugnoli, Montebello di Bertona, Popoli, Ofena

[183] Municipalities: Lucoli, Ovindoli, Rocca di Cambio, Rocca di Mezzo

direct and free interventions of recovery and restoration of damaged buildings in case of: *coherence of the interventions with pre-existing town planning instruments; acknowledged sufficient conditions for the reintroduction of pre-existing functions and activities*. The interventions, ahead of actions for wider urban transformations, need to not contrast with the strategic guidelines for the re-planning of the territory" (Comune di L'Aquila, 2011a, p. 80). Nevertheless the attempts to modulate differently the reconstruction in different areas, L'Aquila's Reconstruction plan openly suggested a reconstruction "com'era dov'era" of the built environment in the historical centre.

Complying with laws' requirements, the Plans (both of L'Aquila and of HAs 4, 5 and 9) contain also preliminary project proposals for the first and second goal of the reconstruction process: "to ensure social and economic recovery" and "to promote urban redevelopment". These proposals unsurprisingly involve a scale larger than the mere extension of the *perimetrazioni*, and consequently they cannot have a mandatory role but only an indicative nature. The Plans for the HAs 4, 5 and 9 include pilot projects of urban regeneration as well as long-term strategic scenarios, based mainly on the promotion of naturalistic tourism and sustainable local agriculture, a strategy suggested by the high environmental quality of these territories. The Reconstruction Plan of L'Aquila as well includes not only "direct interventions" but also urban "Strategic Projects" (mainly private interventions) for the unitary reorganization and urban regeneration of specific areas at the borders of the historical centre, and "Strategic Guidelines" – about the overall urban order, implementation paths, main interventions and preliminary budget evaluation. These "strategic projects" embedded in the Reconstruction Plan are the only coordination area between the municipal "Strategic Plan" and the Reconstruction Plan for the historical centre.
L'Aquila's Reconstruction Plan sub-divides the city inside the *perimetrazione* in three zones (Figure 86):

- "A-Historical Centre" (further sub-divided), involving the most valuable ancient urban fabrics of the city, where the main purpose of intervention should be the architectural recovery;
- "B-Short Term Areas", areas between the Historical Centre as defined by the Town Plan and the walls of the city: these areas generally present fewer spread damages but more recent and chaotic urban fabrics, where the reconstruction could be addressed also through transformative programs;
- "C-Frontier Areas", which represent places of transition between the ancient core of the city and its suburb.

The proposals of intervention on private buildings followed "municipal notices" *("Avvisi Pubblici")* which were released on summer 2010 for zone B, winter 2010-2011 for zone A and summer 2011 for zone C (Comune di L'Aquila, 2011b, pp. 8-9, 13). Therefore the applications to start up the actual reconstruction had to wait between 15 (zone B) and 26 months (zone C) after the disaster, but the Avvisi Pubblici were released before the adoption of the Reconstruction Plan. Moreover, in order to control public expenditure, the employment of reconstruction funds has been strictly guided by the typology of assets damages and the level of damage induced by the earthquake, adopting the normative criteria of the so-called "*causality nexus between damages and compensations*". Law 77 placed "subsidies" for the restoration and reconstruction of private "buildings" in the Crater (Law no. 77, art. 1 and 3), and "contributions" to help manufacturing activities affected by the earthquake and to face damages occurred to social, sport and religious structures. Financial support for other interventions sketched in the Plans – including the restoration or reconstruction of schools and infrastructures (Commissario delegato per la ricostruzione Presidente della Regione Abruzzo - Struttura Tecnica di Missione, 2010a, p. 25; Ufficio Speciale per la Ricostruzione dei Comuni del Cratere (USRC), 2010, pp. 2-3) – were object of specific ad-hoc evaluations of the damage and its causality nexus with the seismic event. The causality nexus) and the correlation of the funds to the level of damage (as from interviews with USRC and L'Aquila municipality Officials) had clearly influenced the allocation of funds but also the architectural concept of projects, reinforcing the trend of rehabilitation of the pre-existing urban fabric (§Ch.5.4).

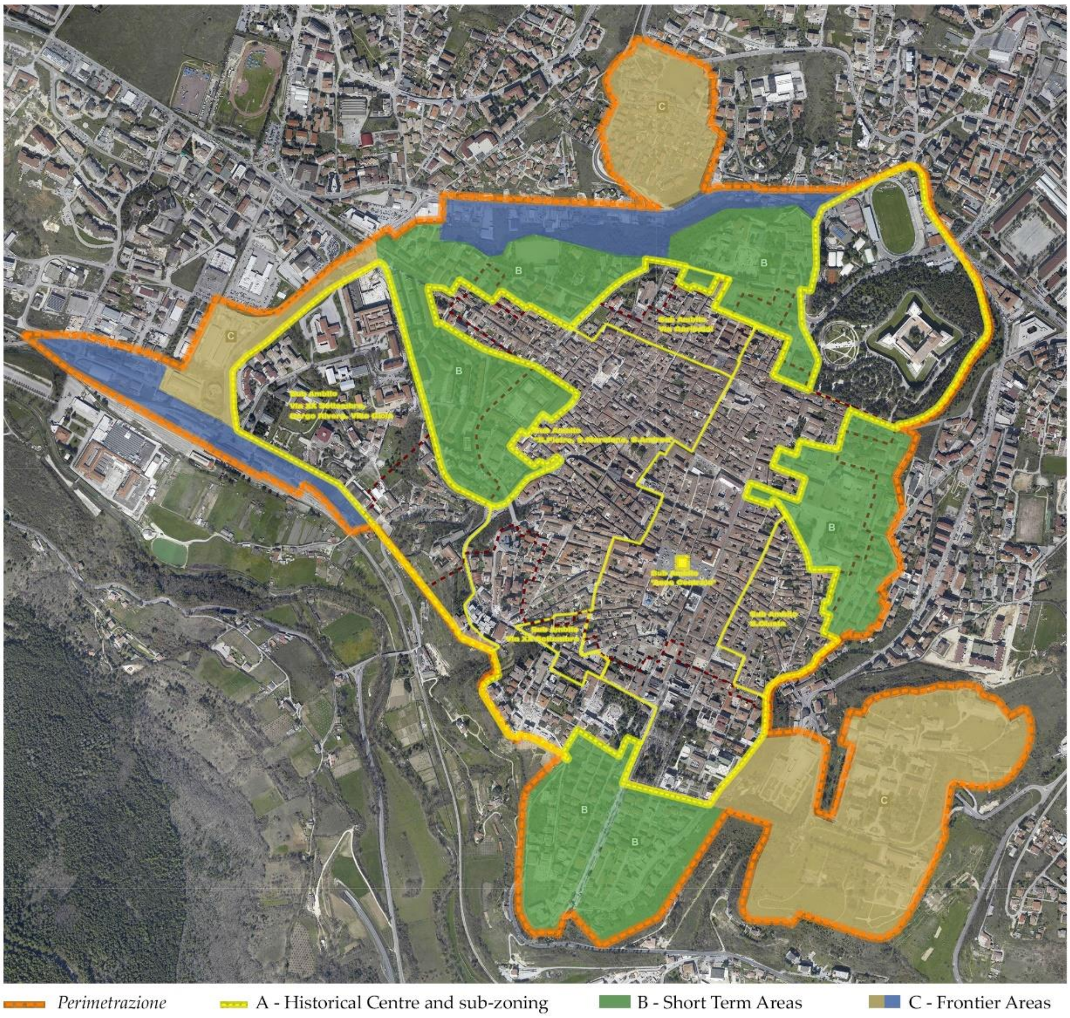


Figure 86. Sub-division of L'Aquila's *perimetrazione*. Elaboration of the author on the Reconstruction Plan, Map no.1 "Perimetrazione e ambiti di ricostruzione"

Planning after the disaster #2: looking at L'Aquila Town Plan(s)

Outside the boundaries of the Reconstruction Plans, the reconstruction process relied on pre-existing urban planning. The "Strategic Guidelines" included in L'Aquila Reconstruction Plan refer to the 2009 Strategic Plan that was in progress at the moment of the earthquake (§Ch.

5.1), reformulating partially some positions for better answering to post-disaster new needs (Table 9). Later on, the Strategic Guidelines of the Reconstruction Plan grounded the post-disaster updated re-formulation of the Strategic Plan presented in November 2012 by the Municipality (Comune di L'Aquila, 2012): the "seismic security" has been here evidently assumed as main objective of the reconstruction process and of the future development of the city, very differently from the 2009 version of the plan.

The activities for the new Town Plan took its first steps only between March and November 2013[184], affirmed as a necessary action to be taken for two compelling reasons: the evident inadequacy of the previous 1970s town plan, and the requirements of Law no. 77 which asked for a "new planning" of the territories struck by the quake[185]. The municipal Planning Department was assisted by Sapienza University of Roma, the University of L'Aquila and CRESA[186]: the "Preliminary Document" for the new town plan was approved on November 2015[187] and a "First Draft" followed, accepted by the Province of L'Aquila (December 2016, substituting the previous Structural Plan realised in 2004-2006), and approved on March 2017[188]. The approval of the plan was instrumental to validate the works done before 2017 municipal elections[189] and safeguard the continuation of the next phases[190]. "To guarantee the security of the territorial vulnerability[191], public health and the support to urban resilience" is stated as goal (no. 5) of the new Town Plan, to be accomplished by "raising the level of urban resilience and anti-seismic safety" and by integrating in the municipal plan wider prescriptions and precautionary measures, such as seismic microzoning[192] or indications from other instruments as regional plans for wildfire, flood and hydrogeological risks (Comune di L'Aquila, 2017, p. 11).

[184] Deliberations of the Municipal Council no. 98, 15th March, and no. 567, 27th November 2013.

[185] Municipal Deliberation no. 98/2013.

[186] Regional Centre for Economic and Social Studies and Research, created by Abruzzo Chambers of Commerce.

[187] Deliberation of the Municipal Council no. 118, 26th November 2015.

[188] Deliberation of the Municipal Council no. 38, 30th March 2017.

[189] In June 2017 Pierluigi Biondi (Fratelli d'Italia, centre-right) was elected as new Mayor of L'Aquila, succeeding to Massimo Cialente who had ruled the city since 2007.

[190] The Plan was indeed presented to the citizenship and to the brand-new municipal administration on 8th July 2017 during the "Participation Festival" held yearly in L'Aquila since 2016.

[191] Translation from the Italian text, quite ambiguous also in the original version.

[192] The seismic microzoning for L'Aquila area was initially developed by the National Department of Civil Protection in 2009-2011 only for the most damaged areas of the Crater. Made obligatory integration of planning tools by Regional Law no. 28 (2011), the microzoning was expanded and completed by Abruzzo Region (https://protezionecivile.regione.abruzzo.it/index.php/microzonazione).

Year	L'Aquila Planning	Year	Regional Planning
1975/79	Town Plan	1990	Regional Landscape Plan
2001/07	Studies for a new Town Plan **(interrupted)**		
2004	Structural Plan **(never approved by the Province)**	2004	Studies for the new Regional Landscape Plan **(in progress)**
2009	Strategic Plan (first drafted version)	2008	Plans for Flood Risk (PSDA) and Hydrological Risks (PAI)
2009 earthquake			
2012	Reconstruction Plan for the historical centres; Strategic Plan (second version)		
2013/2017	Preliminary documents for the new Town Plan **(in progress)**	2016	New Flood Risk Plan for "Central Apennines"District

Table 9. Summary of planning instruments and research before and after the earthquake (expansion of Table 7). Elaboration of the author.

The new Town Plan has reviewed the residual planning previsions inherited from the past, mapped all the territorial transformations occurred after the earthquake, and integrated planning strategies with the analysis of nature-related risks thought GIS systems. The availability of data about nature-related risks was an important point in the plan: the first seismic microzoning done by the Civil Protection didn't involve all the L'Aquila's hamlets and was completed afterwards by the Region; the regional Flood Defence plan and Landscape Plan are under review. Such rigidity has affected consequently also L'Aquila's town plan design (interview with an Official of L'Aquila Municipality).

Since the new town plan is still in progress, and the Strategic Plan doesn't have a regulatory role on land uses and transformation, the only plans in force at the moment of the earthquake were the 1979 Town Plan and the 1990 Regional Landscape Plan; at the moment of writing, the 2012 Reconstruction Plan completes the framework but only for the historical centres of the city and of its hamlets: all the rest of the municipal territory is still ruled by 1979 town plan together with the 1972 city Building Regulation *(regolamento edilizio)* – partially updated in 2007.

5.4 LOOKING INSIDE THE WORKING SITES: THE BUILDING SCALE

Building Units and Building Aggregates

The complexity of a reconstruction and of its rules involves also the building scale of the process. The identification of "building units" and "building aggregates" (OPCM. 3820, 2009, art. 7) is at the core of the analysis of the damaged building heritage. The "building unit" (shortly "building") identifies "a portion of the urban fabric made of a three-dimensional aggregation of 'roof-to-foundation' built cells and characterised by individuality from the typological, morphological, architectural, structural and functional standpoints. The building unit usually consists of several real estate units" (Liotta, Raglione, Ronchetti, & Sorrentino, 2013, p. 85). Buildings can be isolated or aggregated: the "building aggregate" is a set of contiguous and interconnected (but non-homogeneous) "buildings" which can interact if solicited by a dynamic action such as an earthquake. In historical centres the aggregate – if there are no joints or internal structural disconnections among buildings – coincides with the urban block delimited by streets and squares (DM. 14 gennaio, 2008, chap. 8; ReLUIS, 2010, p. 7). Building aggregates (shortly "aggregates") strongly characterize Italian historical centres where building completion and urban expansions occurred for centuries in adjacency and continuity with pre-existing buildings. The identification of the aggregate is preliminary to the definition of the building interventions, to the establishment of owners' consortia and to financing procedures (Comune di L'Aquila, 2011c, p. 7). In fact, building aggregates frequently suffer considerable damages after seismic shocks, but improving their performance is particularly difficult because of the fragmentation of properties, which leads to a dangerous fragmentation of interventions; simulations show how interventions on the whole aggregate improve substantially the buildings' anti-seismic performance, unlike interventions conducted partially, only on some building units of an aggregate (Sorrentino, Lancia, & Fumagalli, 2012): "Independent intervention strategies on portions of the same aggregate can lead to overall disappointing outcomes. This is exacerbated by the fact that the separation between owners makes [them] unaware of the problem, and relocate the damage [due to a future earthquake] on the aggregate portions where no intervention was carried out" (Sorrentino et al., 2012, p. 252). Owners are obliged to establish a consortium with a President – elected with the agreement of owners of the 51% of the aggregate surface, acting as legal representative, almost as a "condominium administration" – or delegating a Special Commissioner (in this case the 100% of owners must agree). If owners refuse to gather in a consortium, the Municipality is in charge of constituting compulsory consortia and nominee an extraordinary commissioner.

Until the closure of the emergency phase, the reconstruction was mainly guided by special ordinances (OPCM. 3778, 2009; OPCM. 3779, 2009; OPCM. 3790, 2009; OPCM. 3881, 2010) addressing the restoration of *isolated building units* outside the historical centres involved in reconstruction plans (outside the *perimetrazioni*) and guided by the habitability status (granting with higher compensations the most damaged houses) and property of the buildings[193]. This "old" procedure was integrated by the Decree in 2013 (DPCM. 4 febbraio, 2013) which introduced the so-called "*scheda parametrica*" ("parametric model") for granting monetary contributions for building reconstruction inside the historical centres. The "new" parametric-based funding scheme moves firstly from an evaluation of damages and vulnerabilities of the structure and – in a second phase of evaluation – in the light of the reconstruction project, with thresholds of compensation based anyhow on the post-earthquake habitability status. This new procedure aimed mainly at restoring complex *building aggregates* in the historical centres, and then extended also to L'Aquila peripheries by USRA Office[194]; the priority was given to the so-called "Central Axis" of the Reconstruction

[193] Residents' or non-residents' houses

[194] Notification of 18th July 2013

Plan (Figure 86, located in zone A), namely the areas along the central street (Corso Federico II, Corso Vittorio Emanuele) (Baldassarre et al., 2015). Figure 87 shows clearly the prevalence of old procedures (according to OPCM) in the peripheries, and therefore involving the majority of cases); on the contrary, the new parametric model was massively applied in historical nuclei.

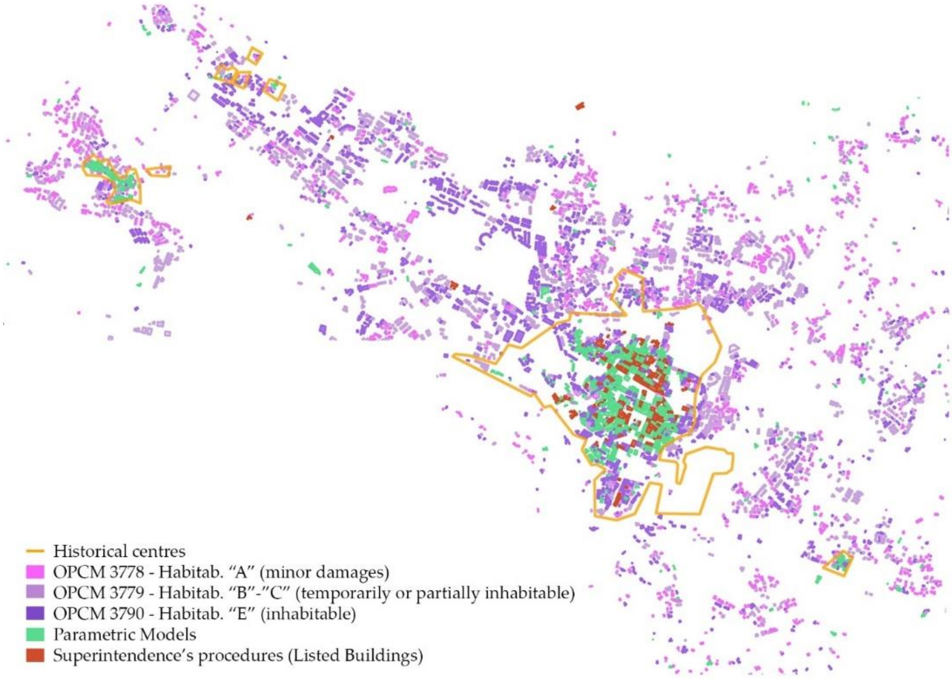


Figure 87. Reconstruction of private buildings according to the "old" (OPCM) or the "new" (Parametric Models) procedure in L'Aquila historical centres and nearest suburbs. Elaboration of the author from USRA webgis[195].

"Com'era Dov'era" by Law?

OPCM 3778 and 3779 – addressing habitable (A) of temporarily/partially inhabitable (B-C) buildings – consider the necessary repair works as "ordinary maintenance works" and therefore cannot lead to changes in the use, configuration, aesthetics and building parameters of the original building (obviously following the national newest technical building regulations in terms of anti-seismic standards); designers are asked to declare that their projects respect the formal and aesthetic features of the pre-earthquake status (OPCM 3778, art.1; OPCM 3779, art. 1, 2). OPCM 3790 manages the reconstruction for inhabitable buildings (E), hence seriously damaged, but it frames the reconstruction works using the exact same words: no change in the use, configuration, aesthetics and building parameters is allowed (art. 1, 2)[196]. Moreover, a reconstruction different from pre-earthquake status, being a "new construction" required the respect of urban standards and building regulations required by current legislation and local regulatory instruments (such as building characteristics as distances or heights, provision of space for urban green areas, parking and

[195] http://webgis.comuneaq.usra.it/mappa_def.php, accessed on 2nd August 2018.

[196] Notwithstanding the OPCM, secondary changes in aesthetical architectural features occurred in the city (e.g. transformation of facades or building shapes) in cases of total reconstruction of ordinary buildings.

services, etc.). The three OPCM imposed de facto a “com’era dov’era” reconstruction, strongly reducing the transformational potential even in the suburbs outside the Reconstruction Plans, where no landscape or architectural peculiar values needed to be preserved (differently from the historical centres). Besides, additional interventions beyond the “rebuilding” are not financed by public funds but are charged to the owners – e.g. voluntary demolitions for achieving a greater seismic security, addition of private underground parking while exploiting the excavation works, etc. – reducing even more the options for fostering transformative projects and urban renovation at the mesoscale (interviews with an engineer and a researcher from L’Aquila). L’Aquila has already a large availability of homes per family: the esteems available in L’Aquila new Town Plan (updated to 2016) count ≈30.500 families for ≈47.000 dwellings, with about ≈12.000 unoccupied dwellings (the latter were ≈7.000 in 2001)(Comune di L'Aquila, 2017, pp. 124-125): many buildings are not “necessary” to their owners, who are even free of selling after 2 years of the “provision” of the reconstruction grant (provision, not “closure of works”). Consequently, the interest in investing extra money on such dwellings is clearly lower.

Simplifying a quite complex aspect of building regulation, it’s necessary to recall that Italian “Building Code” (DM. 14 gennaio, 2008) demand two main kinds of intervention on existing buildings in seismic areas: the so-called “seismic retrofitting standards” (*adeguamento sismico*) and “seismic improvement standards” (*miglioramento sismico*) for minor interventions. In the first case, the renovated building must offer the same level of seismic resistance of a brand-new structure (total); in the second case, the Codes allow “lower” safety levels to achieve. Legislation imposes the achievement of “retrofitting” or “improvement” levels according to a very large range of criteria, depending on the pre-existing conditions of the building, its uses, the typology or extension of necessary works. Nevertheless the ambition, often a structure demolished and rebuilt according to the newest building codes is perceived as “safer” than a repaired one[197]. It’s necessary to underline that for listed buildings or buildings with peculiar cultural or architectural values, the Building Codes allow lower levels of seismic improvements to safeguard the architectural heritage[198], and this is the case for many residential buildings in the historical centres (Ciccozzi, 2015).
About the voluntary demolitions, condominium regulations have strongly influenced the design choices of rebuilding projects, together with the binding principles ruling the funds. Exemplar cases have been recalled by a researcher (and inhabitant) from L’Aquila in our interview: two Condominiums declared “E” (inhabitable) located next to the historical centre were “repaired” and not “rebuild” because of the disagreement among owners about the voluntary demolition, allowed in such cases. In one case, out of 17 owners only 1 took position against the demolition, but since unanimity is compulsory for proceeding to a voluntary demolition, the building was repaired.

The DCPM 4th February 2013 introduced the possibility to demolish and rebuild buildings that are considered “incongruous” with the historical urban landscape (e.g. buildings realised in reinforced concrete with no peculiar architectural value). In such cases, the reconstruction

[197] This is obviously a “theoretical hypothesis”, since retrofitting works can be implemented perfectly and reach a very high level of security, while a reconstruction from scratch could be poorly realised, giving birth to a dangerous edifice

[198] “Guidelines for the assessment and reduction of seismic risk of cultural heritage in line with the new Building Codes”, issued by the Ministry for the Cultural Heritage no.26/2010.

can foresee new constructive typological definitions also inside the historical centres, intervening through detailed urban plans. The general indications of the Reconstruction Plans define three types of intervention (Comune di L'Aquila, 2011a, p. 133):

1. **"Direct" reconstruction works**, to be implemented immediately in accordance with the current Town Plan (70% of cases) or in variation of the Town Plan (treated as "unitary interventions", see following point);
2. **"Unitary Interventions"**, public or private, to be implemented using the tools provided for by state and regional laws: Integrated Urban Programs, Recovery Plans, Urban Recovery Programs (15% of cases)
3. **Public interventions** (15% of cases)

The "unitary interventions" (second case) allow modification to the pre-existing status quo and to town planning regulation, but need the design of an implementation plan that must be approved by the Municipality's technical offices, procedure that clearly requires a longer time for its definition and implementation than the reconstruction "as it was" of each single building or each single aggregate – and the cost of design activities for the plans are not refunded by post-earthquake funds (interview, L'Aquila engineer and builder).
The reconstruction of building aggregates requires a consortium of owners, therefore aggregates represent an interesting meso-scale which calls attention to the criticalities and opportunities of the post-disaster recovery. In this perspective, some cases have been further analysed by the author: "Campo di Fossa" (A), "Via delle Bone Novelle" (B), "Banca d'Italia" (C) and "Consorzio 201" (D) cases indicated in Figure 88.

Figure 88. Location of the investigated cases. Elaboration of the author on Bing Maps.

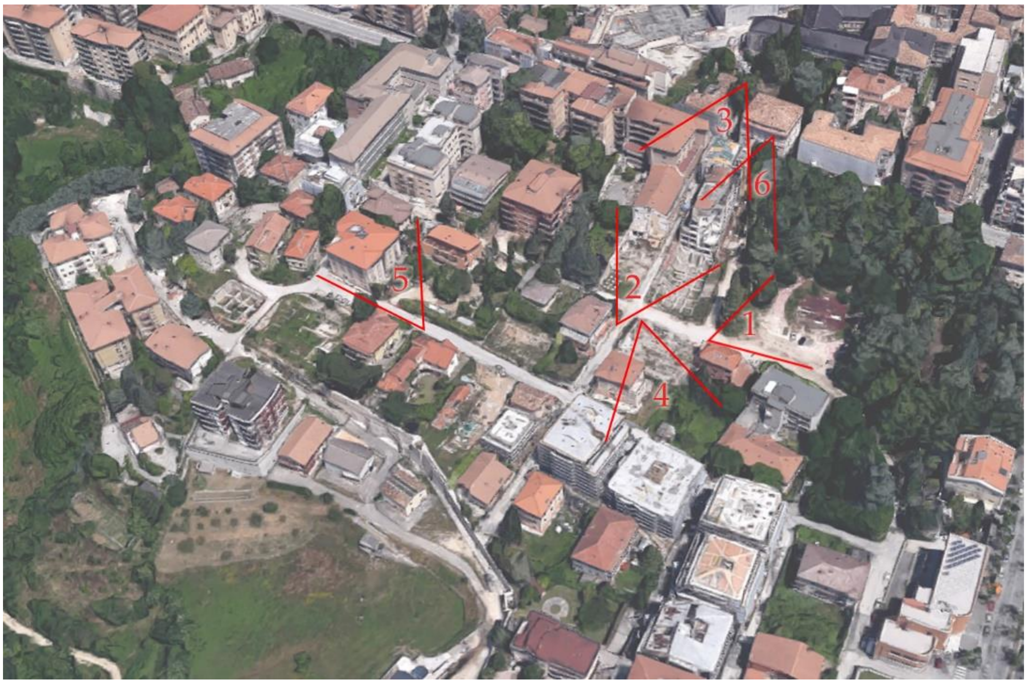
Campo di Fossa [A]. In the vicinity of the historical Centre[199], this neighbourhood was expected to be the object of a unitary intervention, precisely a "Private Strategic Project" – already sketched by the Reconstruction Plan ("G" area Sant'Andrea-Campo di Fossa) – to be implemented through an Urban Recovery Program (≈111 mln euros) (Comune di L'Aquila, 2011d, p. 4). The area was urbanized mainly between the 1915 earthquake and the 1960s, and was severely damaged by the 2009 earthquake: it numbered a large percentage of all L'Aquila's victims (Calandra, 2012a, pp. 127-128), because of the numerous underground caves and thick debris layers which characterise the soil, together with a general poor building quality. In fact, the damages in the area required to produce a very detailed microzoning study for ensuring a more in-depth knowledge of the characteristics of the soil before defining the rebuilding projects (Comune di L'Aquila, 2011b, pp. 31-32). The purposes of this "strategic project", as stated in the Reconstruction Plan, were urban reorganisation and regeneration (even by decreasing the building density) for improving accessibility and usability of public spaces and ameliorating the rapport with the historical heritage (namely parts the urban walls which partially delimit the neighbourhood) (Comune di L'Aquila, 2011d, pp. 45-47). Differently from what stated by the Reconstruction Plan, the reconstruction of Campo di Fossa neighbourhood (largely realized or undergoing at the time of writing)[200] wasn't implemented by a comprehensive urban program but just through the autonomous rebuilding of each construction "as it was". At the moment of writing, the neighbourhoodis almost completely rebuilt with direct interventions on each building, while the reorganization of Piazzale Paoli (Figure 89, 1) and the surrounding gardens as a Memorial Park of the earthquake victims[201] – object of an architectural competition in 2013 – still waits to be implemented. According to local online press some inhabitants are asking a redefinition of the park project to be more compliant to the pre-earthquake shape – displacing the memorial – while other inhabitants and relatives of the victims even requested the non-reconstruction of the building in Via Campo di Fossa no. 6b (Figure 89, 2) whose collapse killed 27 people[202] not rebuilt yet.

[199] It's not part of the historical centre but included in the sub-zoning "A-Historical Centre" of the Reconstruction Plan, see Figure 86.

[200] For further analyses on the recovery of Campo di Fossa, see Fontana (2017).

[201] In 2013 L'Aquila Municipality issued a "competition of ideas" for the design of a memorial park in Piazzale Paoli, won by the Italian architects Gaeta and Di Luzio. The call for tenders for the public work is expected for the second half of 2018.

[202] Sources: http://www.abruzzoweb.it/contenuti/sisma-persero-figlio-in-via-campo-di-fossa-non-ricostruite-il-palazzo-della-morte-/662175-302/; http://news-town.it/cronaca/18739-parco-della-memoria,-piccinini-parte-degli-aquilani-dicono-basta-al-ricordo-delle-vittime.html). According to two interviewees, some inhabitants of Via Campo di Fossa will renounce to rebuild their flats obtaining some "equivalent houses" now owned by the Municipality. As allowed by 2009 and 2010 special post-earthquake legislation for E buildings, owners of could choose to not-rebuild their houses by leaving the ownership to the Municipality and obtaining a monetary subsidy for buying a new "equivalent house" elsewhere. Due to this procedure, the municipality of L'Aquila currently owns 576 residential units, mainly in the city centre (http://opendataricostruzione.gssi.it/ricostruzione-privata/alloggi).



1 - Piazzale Paoli.

2, 3 - Via Campo di Fossa

4, 5, 6 - different stages in the reconstruction works.

Figure 89. Campo di Fossa, Aerial view and implementation of the reconstruction works.
Elaboration on Google Image and pictures (August 2018) by the author.

Via delle Bone Novelle [B][203]**.** The aggregates in Via delle Bone Novelle is composed of 5 contiguous severely damaged buildings with varied collective and private ownerships, and belongs to the sub-zoning "A-Historical Centre – Central Axis". Originally composed of 6 buildings, the first (building 'a') asked and obtained by the Regional Court a physical

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[203] Information about Bone Novelle case are based on the interview with one of the designers of the reconstruction project.

detachment from the aggregate for proceeding autonomously to the reconstruction works (almost completed at the time of writing). The composition of the aggregate is rather complex:

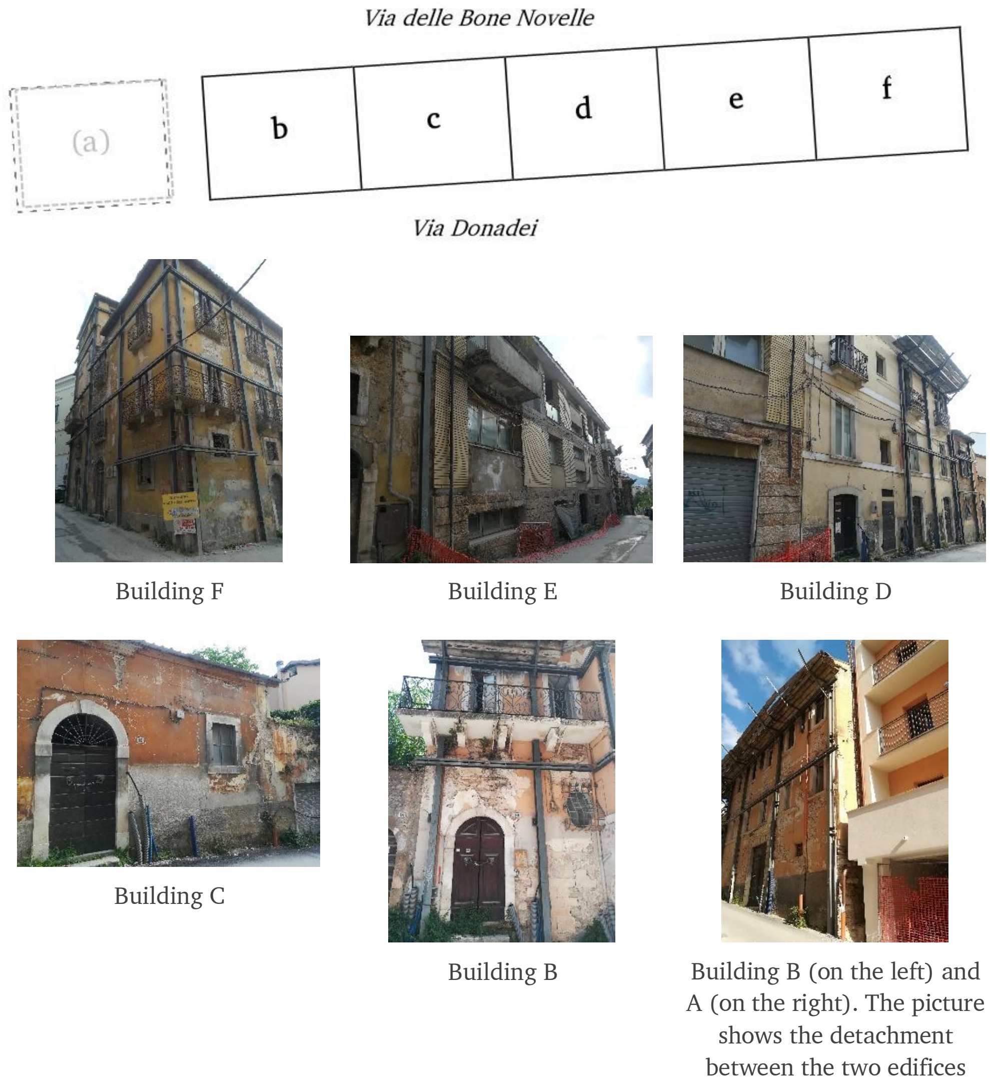

Figure 90. Scheme of Via delle Bone Novelle aggregate. Elaboration and pictures (July 2018) of the author.

- Buildings **'b', 'c' and 'd'**: private residential buildings, one recognised as "destroyed"[204]
- Building **'e'**: property of the Italian Automobile Club (ACI, public company): built in the '60s in reinforced concrete, it has been recognised as "incongruous" for the historical urban landscape.
- Building **'f'**: property of the former (now abolished) "Mountain Community Amiternina" and Abruzzo Region, and it's currently a "listed building" after been

[204] Buildings are considered "destroyed" in case of: a total or partial collapse superior to 25% of the total volume of the building; severe displacement of pillars; if the demolition and subsequent reconstruction is cheaper than the repair works, allowing a seismic improvement up to 80% of the safety adjustment (OPCM. 3832, 2009, art. 9, par. 2; OPCM. 3881, 2010, art.5, par. 5). Note 1 of the Commissario delegato ai sensi del decreto del presidente del consiglio dei ministri del 6 aprile 2009 (2012)

evaluated in 2013 (therefore after the earthquake) as "building of architectural value" because of the quality of its facades (even if the interiors had been deeply manipulated in the past).

The first paperwork for starting the reconstruction project was accepted by the Technical Offices in June 2012, integrated according to the Decree 4th February 2013 and again positively accepted in 2014. The owners' Consortium decided to proceed with a Recovery Plan – therefore a "unitary intervention" – for being allowed to introduce modifications to the pre-existing status quo (except for the "f' building since listed), and to *demolish&rebuild* also the non-destroyed buildings[205]. Nevertheless the ambition of the Recovery Plan, buildings will be rebuilt almost identical to the pre-earthquake conditions, since a different option would get the project rather complicated, requiring the fulfilment of all the "current" architectural and urban standards (distances, height limits, etc.). Even internal modifications aren't easily achievable even if allowed, since main transformations need the agreement between owners requiring a "reallocation" of surfaces among them. Consequently, often the internal distribution remains the same too for avoiding controversy (keeping also former distribution inaccuracies).

Banca d'Italia [C][206]. As for Campo di Fossa case, the area is in the vicinity of the Historical Centre (sub-zoning "B-Short Term Areas") and it's the object of an Urban Recovery Program (≈18 mln euros), listed among the "Private Strategic Projects" ("A" or "5", area Banca D'Italia-Via XX Settembre) sketched by the Reconstruction Plan (Comune di L'Aquila, 2011d, p. 4). The scope of intervention is "urban redevelopment and regeneration of the most damaged areas". The area was the outcome of an urban expansion project dating back to the 1960s/1970s, with no particular urban or architectural quality; at the time of the earthquake, it was occupied by three residential buildings (two private, one public collapsed after the quake[207]) and a fourth office building[208] (Comune di L'Aquila, 2011d, p. 25). The Urban Recovery Program – designed by a temporary association of designers[209] – was initially submitted to the Municipality in February 2011 answering to the "municipal notice for Zone B" ("*avviso pubblico*") released on June 2010; the program was updated and modified by summer 2014, also because of the lack of unanimous agreement among the owners about some design choices. The Program was finally approved by the Municipality and the Province of L'Aquila between October 2014 and May 2015.The program consists of the demolition and reconstruction of the 4 buildings, proposing a different urban fabric and architectural composition compared to pre-earthquake conditions but respecting the location of each building to the pre-existing lots "to smooth the conflicts among owners" (LAQ Architettura et al., 2014, p. 6). From the architectural point of view, the proposal recalls contemporary North-

[205] In case of direct reconstruction works, "Demolition&Reconstruction" operations are allowed only for "destroyed" buildings, see footnote 204. Note than the "rebuilding from scratch" is theoretically the best operation that allows to obtain a fully anti-seismic building structure. Nevertheless, it is not a simple option to apply in several cases.

[206] The information about Banca d'Italia case are based on the interview with a designer from LAQ Architecture Atelier (co-designers of the project) and on the wide documents available online on the Municipality website and local press (http://news-town.it/cronaca/20936-ricostruzione,-il-progetto-unitario-di-via-xx-settembre-%C3%A8-ancora-congelato-il-comune-potrebbe-finanziare-la-riqualificazione-dell-area-con-la-piazza-attrezzata.html).

[207] Owned by Ater, manager company for the local public housing building stock.

[208] Owned by Anas, National Roads Agency.

[209] Including LAQ Architecture Atelier, interviewed by the author.

European architectural languages promoting highly energy-efficient buildings; from an urban design perspective, the program introduces a central public square and pedestrian paths for ameliorating the quality of the public spaces and the accessibility of the area. Commercial arcades and additional parking lots complete the plan. Therefore, the program required a variation to the '70s town plan. According to the plan, the owners are asked to realise the public square and donate the land (≈ 2.900 sq. mt.) to the Municipality, receiving extra building prizes (LAQ Architettura et al., 2014, pp. 8, 21). The owners of the two private condominiums had assumed to cede some building prizes to the building company, which would have then realized the square. Difficulties among owners precluded the progression of works – still frozen at the time of writing. A variant to the approved program has been hypothesised: the Municipality would declare the realisation of the square as "work of public interest" taking on the building costs, but the owners should transfer the necessary surfaces free of charge (and in case of disagreements among owners, the municipality should expropriate the area); moreover due to recent national regulations ("Piano Casa" program[210]) landowners could be entitled of some additional building rights without giving up any land to the Municipality. Furthermore, the project will probably need to be reformulated by eliminating some commercial activities. At the time of writing, the fate of the Program is still unclear.

Figure 91. The project for Banca d'Italia area elaborated by LAQ Architettura Atelier. Details from "Pianta Piazza Pubblica e Prospetti, Drawing AR05"[211].

[210] A national program promulge by Berlusconi government in 2009 for increasing the housing supply and supporting the building sector, to be implemented through agreements and co-financing from local authorities (DPCM 16th July 2009).

[211] Retrieved from: www.comune.laquila.it/moduli/output_immagine.php?id=9657

 

Figure 92 - Figure 93: Banca d'Italia area. On the left the writing "the dignity of my children trampled by an infamous bureaucracy". Pictures by the author (September 2018).

Consorzio 201 [D]. A union of L'Aquila Building Cooperatives was established in September 1973 and received two plots of land in Pettino (west suburb of the city) from the Municipality of L'Aquila, as part of a Public and Social Housing Program ("*Piano di Edilizia Economica e Popolare*"). Seven buildings and 29 terraced houses were built in late '70s/early '80s for a total of 201 dwellings which were assigned to members of the Cooperatives in a "undivided ownership" status (Figure 94). In 2005 the Cooperatives started the procedures to switch to a "divided individual ownership" status of each member. The conversion was approved by Abruzzo Region in 2008 for 199 owners (2 owners preferred to maintain a shared ownership) but the procedures were interrupted by the 2009 earthquake, which severely damaged the buildings, and the ownership remained undivided. The Consortium started the request of funds for the reconstruction works, prioritizing the less damaged dwellings. In the meantime, one owner opened a legal process, assuming the 2008 approval as a transfer of property rights (and not only "surface rights") for his flat. In 2010 and 2011 two Courts rejected the process, confirming the undivided ownership for the 201 dwellings. Nonetheless, the same owner issued request for public funds for buying an "equivalent home" (see footnote 203) elsewhere declaring himself "owner" of his destroyed flat, entrusting the Municipality of L'Aquila of the ownership of the dwellings in Pettino. Conversely, in 2012 the *"Avvocatura Distrettuale of L'Aquila"* ("L'Aquila Government Legal Service") approved the request, creating a precedent for other 77 requests that followed and were approved[212], breaking the Consortium and opening a "legal impasse" since the remaining owners reclaimed the full undivided ownership on all the dwellings, therefore hampering the Municipality to use "its dwellings"[213]. In the meantime, although the pending aforementioned judicial procedures, the reconstruction project was presented and approved between 2011 and 2014 for ≈66 million euros (the most expensive private reconstruction site of the entire Crater)[214], envisioned as a "Demolition&Reconstruction" intervention for the 7 main buildings[215] (Figure 94), following

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[212] Source: local online press (http://news-town.it/cronaca/13740-l-aquila-la-vicenda-delle-cooperative-edilizie,-tra-diritti-di-superficie-e-di-propriet%C3%A0.html; http://www.ilcentro.it/l-aquila/il-comune-ok-le-case-equivalenti-a-pettino-1.223938?utm_medium=migrazione.

[213] Source: local online press (http://www.ilcentro.it/l-aquila/immobili-a-pettino-braccio-di-ferro-comune-consorzio-1.203122?utm_medium=migrazione; http://www.abruzzoweb.it/contenuti/l-aquila-inquilini-via-di-vincenzo-al-201-case-barattate-per-la-caserma-rossi/655227-4/)

[214] Data from http://opendataricostruzione.gssi.it/ricostruzione-privata/richiedenti

[215] Named B1, B4 – both demolished after the quake –, B6, C2, C3, C4, C5. The total area is ≈ 42.000 sq. mt., and residential surfaces are about ≈ 20.000 sq. mt. Information available at https://consorzio201.it/consorzio-201/il-progetto

pre-earthquake urban structure and building volumes but allowing broader transformation to the architectural shapes and facades. The construction site opened in 2014 and the works were completed in 2018; some flats are already inhabited at the time of writing (Figure 96-97), with the co-ownership of L'Aquila Municipality


Figure 94 - Figure 95. Consorzio 201 before the earthquake and during the demolition works. (Source: Google Street View)


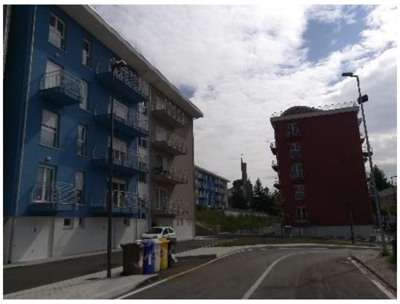

Figure 96 - Figure 97. Consorzio 201 rebuilt. Pictures by the author (September 2018)

5.5 DISCUSSING L'AQUILA: A CAGED WINDOW OF OPPORTUNITY

The inconceivable challenge between restoration and transformation #1: the urban scale

The legislation issued after the earthquake entrusted the reconstruction process and the Reconstruction Plans of ambitious short-term and long-term goals, as along with the Reconstruction Plans, to avoid a mere "physical rebuilding" and exploit the recovery phase to address economic and social matters. Despite the acknowledged purposes of conceiving scenarios able to combine safeguard and development of the settlements (Fabietti, 2012), the same legislation limited the weight of the Plans and the transformative potential of the reconstruction process. The different binding roles of tools and sub-tools contributed to disconnect the physical reconstruction from social and economic long-term strategies.
Firstly, the narrow perimeters of the Reconstruction Plans involving only the historical centres of the town settlements and not the entire municipalities downgraded the actual operative potential of the plans (Andreassi, 2012, p. 23), both in L'Aquila and even more clearly in the minor municipalities. Moreover, in the urban peripheries and suburbs located outside the Reconstruction Plans' boundaries – excluding few special "urban projects" for specific challenging areas, scarcely implemented anyhow – the reconstruction followed a straighter, quicker strategy, based on the restoration/reconstruction of each single building or building aggregate, relying on the pre-existing town planning. The town plans valid in the Crater at

the moment of the earthquake were often outdated, often addressing only the urbanized area and not the entire municipal territory, and normatively and culturally inadequate for managing the post-earthquake territorial development of the area, nonetheless legally still in force. Moving from the position of an interviewee (representative of the 2012-2017 City Council), "the historical centres cannot be replanned but restored and reconstructed, while public and private services – inside and outside the historical centres – need to be re-imaged to ensure a higher quality of urban life, but to achieve that you have to reflect on your urban history", it's necessary to remember that this expensive reconstruction, out in place in the 2010s and cost until now almost 18 billion euros, (see below, and Chiodelli, 2018), couldn't rely on any updated valid long-term large-scale scenario outside the boundaries of the historical centres, and even where planning instruments were in force, they were often dozens of years old[216]. If, on the one hand, the reconstruction plans as imagined for Abruzzo were probably not the correct instrument to address the territorial scale[217], on the other hand there were no other updated instruments "in force", and the reconstruction could have been the occasion for forwarding the design of the new Town Plan – or at least for starting debating about possible development scenarios for the long-term spatial transformation of the city "outside the walls", without postponing it and without delegating it just to the strategic guidelines produced in the various planning documents. Refocusing on the topic of risk reduction, even the distances from active or uncertain faults ("setbacks") to be ensured in urbanization processes represent a quite new standard to insert in the planning instruments in Italian normative (dating back to 2008, Gruppo di lavoro MS, Bramerini, Di Pasquale, Naso, & Severino) and for L'Aquila's plans as well. The importance of not slowing down the reconstruction but to not abandon it to a "long-term vacuum" was described also by the urban planning report about the reconstruction of L'Aquila requested by the Ministry for Territorial Cohesion in 2012 (Oliva, Campos Venuti, & Gasparrini, 2012). The case of L'Aquila is exemplary in the Crater: as explained by the main designer of the new Town Plan currently in progress (interviewed by the author), the historical centre could rely on very detailed information ad regulation offered by the "old" town plan but its reconstruction was "frozen" until the design of the Reconstruction Plans; on the contrary, the suburbs – which needed or could benefit of a present-day replanning effort and of advanced urban retrofitting interventions – were merely rebuilt lot by lot, reshaping the pre-existing spatial structures. How the re-planning of the territory could be assured, as required by Law no.77? Interviews confirmed on the one hand the helpful guiding role of the Strategic Plan drafted before the earthquake, and the weight of the missing an updated Town Plan, on the other.

L'Aquila has been largely rebuilt without any updated planning research, and the new town plan in fieri is now obliged to run after the reconstruction: the power of landowners, and the procedural challenges for unitary interventions have fostered the "Building Question" to devour the Urban Question.

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[216] In HAs 4, 5 and 9 the town plans or building programs – when existing – dated back to the end of '70s or first '90s, and when updated by new tools (generally at the beginning of 2000s) the new urban plans were merely adopted and not approved, and therefore partially in force

[217] According to an interviewee (currently professor of urban planning), the reconstruction plans "financed Italian university research – that was something good anyway – but weren't useful for L'Aquila reconstruction in the way they had been imagined".

The inconceivable challenge between restoration and transformation #2: the building scale, the seismic risk and the reconstruction funds

"L'Aquila reconstruction seems been reduced to a *building question*, while the urban and territorial planning dimension of the problem was never tackled" (Frisch, 2009, p. 27). Already in 2009 George Frisch foresaw a crucial aspect of L'Aquila reconstruction, reaffirmed also in 2014 by Oliva (2014, p. 43) and exposed in the previous paragraph. The three OPCM 3778, 3779, 3790 (§Ch.5.4) imposed de facto a com'era dov'era reconstruction.

Furthermore, the necessary control of the public expenditure through the "causality nexus" between damages and compensations (§Ch.5.3) reduced the transformative purposes of the Plans (interview with USRC official) and somehow the optimization of the public expenditure, since some transformative projects that could be embedded in the reconstruction process optimising the working sites (such as the needed modernization of the underground services) needed ad-hoc evaluations for being granted lacking the direct relation of causality with the seismic event. The causality nexus wins on the "consistency nexus" between needs and strategy. This relation between damage and compensation has been criticised also from a substantial point of view from public Officials: the level of damage of ordinary buildings was assessed through AeDES Forms (§Ch.5.2) whose goal is to orient the first emergency phases, and not to provide conditioning assessments instrumental to the reimbursement processes. In fact, after the correlation between AeDES-related habitability status (A,B,C,E) and financial refund schemes was established by a series of ordinances (§Ch.5.2), the municipal offices received countless requests of revision of AeDES-related habitability status; on the contrary, after Law 134/2012 and DPCM 4th February 2013, the new "parametric model" evaluated both damages and vulnerabilities of the buildings, allowing therefore a more correct and precise estimation of the needed budget.

Until 2012 a "Limit of Economic Convenience" imposed by national laws (OPCM 3881/2010; DCD 27/2010) allowed to demolish not-listed buildings if their reconstruction cost more than ≈1.200 €/sq.mt.: according to the Municipality (interviews at L'Aquila municipality and Comune di L'Aquila (2011a, pp. 257-258), this disposition "threatened" the restoration of the typical urban fabrics and more complex building aggregates that characterized the city, and clashed with the very conservative Technical Standards of the existing Town Plan. The limit of economic convenience influenced also the choices for the voluntary demolitions: if reparation was cheaper, the extra costs for demolishing were charged on the owners. Such fundamental aspect, together with the norms protecting the cultural heritage, have risked subordinating the reduction of seismic risk to budget control on the one hand, and to an integralist restoration culture on the other (Bazzucchi, 2011; Ciccozzi, 2015). Although the difference between "repaired houses" and "rebuilt houses" – the latter "perceived as safer" than restored constructions – is not trivial and has an impact on the real estate market: advertisements in L'Aquila always underline if the house is rebuilt or repaired (often even explaining which anti-seismic techniques were applied) and it is a clear criterion of choice for buyers and tenants in search of accommodation in the city (confirmed by fieldwork and several interviews).

There has been a sort of idealization of the past, which acted as reference for each post-earthquake choice and leads towards a re-proposition of the status-quo (even if non-compliant with new paradigms) in financial (the causality nexus), technical (requirement and guidelines both at building and urban scale), normative (the legislative and the procedural bonds imposed both by the national authorities and by local institutions) and social (easier, quicker, and less conflictual) terms.

The time delay: the permanency of temporary solutions, while postponing long-term scenarios

The large set of rules governing the reconstruction (such as Special Decrees and Ordinances) together with the weak ordinary legislation (local and national) and the intricate history of the Reconstruction Plans[218] gave priority to the reconstruction of the peripheries postponing the historical centres ("the reconstruction stated from the peripheries, and only later in the centres, and this was a State's decision, not ours", as stated by an Official from L'Aquila Municipality), favouring strategies aiming at a quick return to previous conditions and focused on the urgent rehabilitation of building stock (interviews with Officials of USRA and USRC). The effectiveness of freezing of the historical centres until the approvals of the reconstruction plans has been questioned by various interviewees: according to them, the actual possibility of introducing transformations both at urban and building scales has been so limited (as explained in §Ch.5.4) "that the planning instrument didn't add any value to the reconstruction process and "just wasted time". Even if many normative gaps have been filled in time while proceeding with the reconstruction, the necessary economic, normative and fiscal instruments to promote urban regeneration as "third-way of the reconstruction" (between the rush of the peripheries and the freezing of the historical centres) weren't available when needed (namely, sooner). As sarcastically affirmed by an interviewee from L'Aquila Municipality: "Imagine intervening in a complex area where there are several different landowners' consortiums and there are two equal options of action: 1. Define a regeneration project for the entire area, but it requires the agreement of every owner, and at least another couple of years to be realized; 2. Evaluate the projects and assign funds for each consortium, but rebuilding the area as it was prior to the disaster. Which option is quicker, and will be preferred by the inhabitants, according to you?".
We can trace somehow a "matrix" of space-time-damage. In the peripheries: fewer damages, quick re-building interventions, transformations of the urban structure due to new CASE and MAP areas and their infrastructures, without updated planning scenarios. In the historical centre, more damages, a frozen reconstruction delegated to the Reconstruction Plan, no transformations of the pre-existing urban structures but an augmented seismic resilience of the historical urban fabric compared to pre-earthquake status.

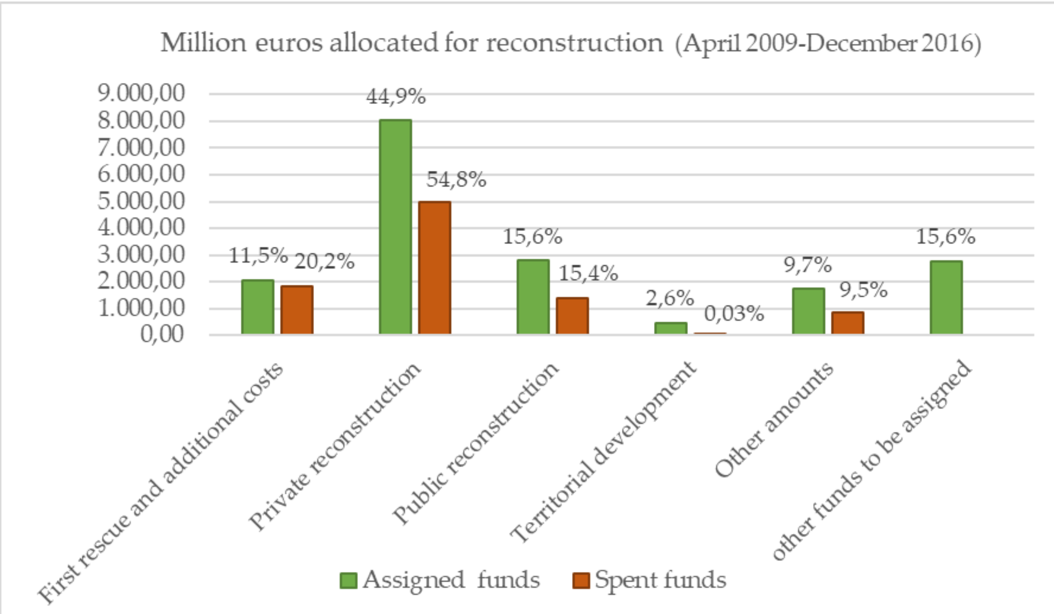
Even if Laws 77 and 134, Decree 3, the Reconstruction Plan for L'Aquila and several Plans of the Crater[219] all "declare" to refuse an approach oriented to restore the "status-quo" or pre-existing conditions, their contradictory regulatory roles weakened the efforts put on the ground to promote more ambitious development projects.
The time delay has reinforced the tendency to treat the reconstruction as a physical rebuilding and the com'era dov'era stigma, confirming what stressed in the literature: both the cruciality of the "speed factor" to exploit the "window of opportunity", and the tendency to restore lives

[218] The long time necessary for setting and approving the Plans – both in L'Aquila (approved 3 years after the earthquake) and in the rest of the Crater (in 2013 when the "emergency phase" was already closed, only 21 plans out of 55 had been approved) – has frozen the historical centres.

[219] The Plans for HAs 4, 5 and 9 proposed preliminary insights and large scale scenarios to support local economies and communities but– as clearly affirmed by the Plans' designers – such proposals deserved to be target of essential policies, wider than what a reconstruction plan can design and imagine (Alberto Clementi & Di Venosa, 2012; Università degli Studi di Padova, Consiglio Nazionale delle Ricerche, Politecnico di Milano, & Sapienza Università di Roma, 2012; Caravaggi, 2013).

and communities perpetuating "the disaster damage cycle rather than address the root causes of the problems" above all in absence of longer-term recovery policies plans (Platt & So, 2016). The time delay underline a sharp contrast with the urgency of some of the first post-emergency "temporary" decisions, whose effect on the territory cannot be dismissed as just "temporary" (like CASE projects[220], or the so-called "MiniHouses", little temporary constructions realised autonomously by L'Aquila citizens and allowed for no longer than 36 months[221]) (Interview with a representative of the former City Council).

The physical reconstruction of the (private) built environment is the priority of this reconstruction, assumption that can be derived from data made available by the official monitoring of funding flows for Abruzzo reconstruction. According to the Mission Structure website[222], between April 2009 and December 2016 the Italian governments allocated more than 17,8 billion euros for the reconstruction, of which 45% for the reconstruction of private buildings (54%, looking at the percentages referred to "spent" finds) and 15,6% for the "public" reconstruction; only 12,3% has been allocated for territorial development and other projects (data that slopes to 9,53% analysing the spent funds) (Graph 1). Data provided by the Interministerial Economic Planning Committee (CIPE)[223] highlight an even higher divide between categories: the reconstruction of private buildings (mainly residential, the author would argue) as absorbed the 73,7% of CIPE grants (Graph 2).



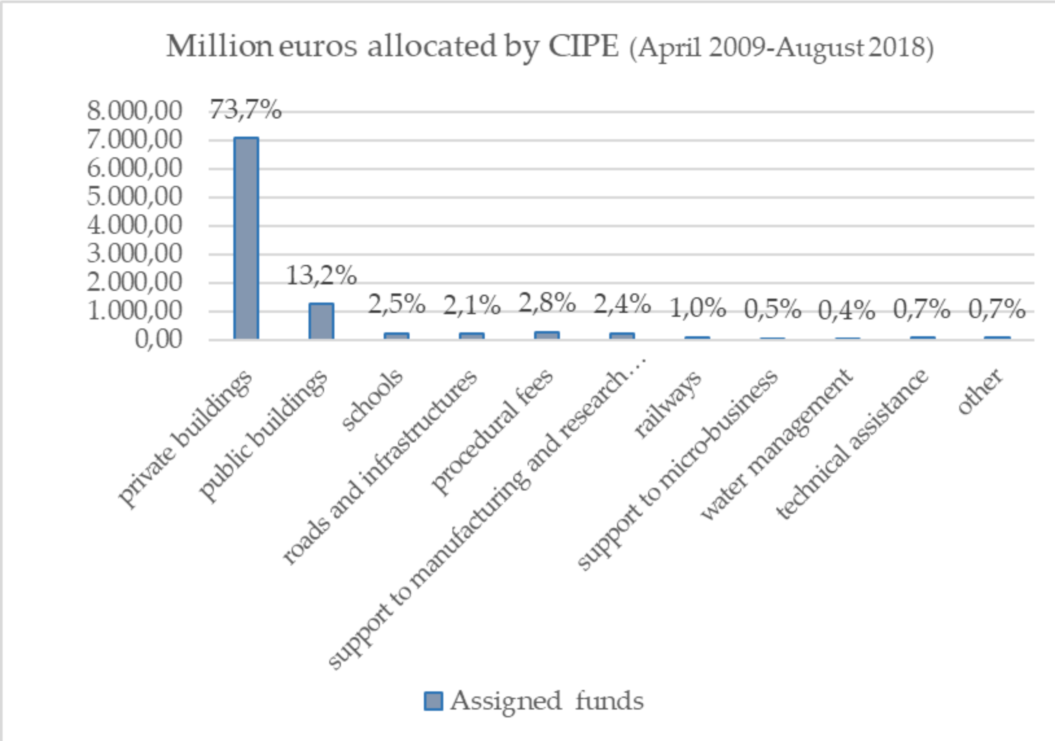
Graph 1. Million euros allocated for the reconstruction, updated on December 2016. Elaboration of the author from the Mission Structure website (footnote 222)

[220] On 31st December 2017, about 10.100 people were still hosted in CASE or MAP projects (Struttura di Missione per il coordinamento dei processi di ricostruzione e di sviluppo nei territori colpiti dal sisma del 6 aprile 2009, 2018, p. 4).

[221] Municipal Decree 58/2009. During the interview, a municipal Official recalled that several mini-houses have been placed even in flood risk-prone areas (int.). 1.042 houses have been realised according this decree (Comune di L'Aquila, 2017, p. 121).

[222] http://sisma2009.governo.it/intervento/ricostruzioni/, accessed on 15th October 2018

[223] These data refer only to the funds managed by CIPE http://www.programmazioneeconomica.gov.it/2018/08/21/ricostruire-labruzzo-3/ accessed on 15th October 2018



Graph 2. Million euros allocated for the reconstruction by the Interministerial Economic Planning Committee (CIPE), updated on August 2018. Elaboration of the author from CIPE website (footnote 223).

The priority given to the physical reconstruction of the built environment, postponing wider development projects addressing social and economic weaknesses and potential of the area, is evident from the graphs. In L'Aquila the "overbuilding problem" is demonstrated from data, as the esteems about ≈12.000 unoccupied dwellings in the city (§Ch.5.4) (Comune di L'Aquila, 2017, pp. 124-125; Fontana, 2017). Even if data about the real estate market are partial because they do not include the historical centre of L'Aquila, they indicate that the average cost for residential dwellings in L'Aquila municipality in 2017 was 711 €/sq.mt. (Osservatorio del Mercato Immobiliare, 2018, p. 10): it is the second to last lowest price of all provincial capital cities in Italy[224]. Interviews with freelance designers confirm the worrying trend: the purchase price is often lower than the construction cost of the dwelling. In a dispersed and shrinking territory as Abruzzo, and in the light of the demographic tiny size and the ageing index of the rest of Crater, the future of this renovated building stock is even more uncertain, above all in light of the scarce investments for social and economic territorial relaunch[225]: for whom such public money was spent?

This divide highlights the lack of attention given to one of the main broad goals of the special post-earthquake legislation – "to foster long-term development" – and to the wide and diversified expert consultancies and research activities (both national and international) mobilized by L'Aquila earthquake, which generally provided: i. analyses of pre-disaster features

[224] The cheapest cost is in Caltanissetta (Sicily): 611 €/sq.mt.

[225] Two interviewees (one freelance designer from L'Aquila and a university professor) recounted cases of owners of renovated buildings who tried to refuse to take their houses back because they didn't need them and were afraid of the related taxation without being able to sell or locate the dwellings. So, for instance, owners bricked up windows and doors, or detached the houses from the essential networks systems (e.g. water facilities) so that dwellings cannot be considered "habitable" and owners could pay reduced taxes.

and peculiarities of the city and the Crater; ii. guidelines for policy making; iii. expert support for specific interventions. Already on July 2009, the Organisation for Economic Cooperation and Development (OECD) and the Italian Ministry of Economy and Finance co-organised a workshop with government representatives, private sector, academia and civil society for discussing policy options to re-launch L'Aquila's economy (OECD, 2009); OECD delivered also a full report on policy making after a disaster for L'Aquila case study in 2013 with the support of the Department for Development and Economic Cohesion (DPS) in the Ministry of Economic Development (OECD, 2013). In 2010 the Italian National Institute of Urban Planning (INU) held a series of workshop in the city, involving a multidisciplinary team of experts and that led to a "White Book" on the Reconstruction (Laboratorio Urbanistico per la Ricostruzione dell'Aquila, 2010). In 2012 the Ministry for Territorial Cohesion promoted three studies dedicated to L'Aquila: a study on the socio-economic future of the territory (Calafati, 2012); an urban planning report about the reconstruction and development of the city of L'Aquila (Oliva et al., 2012); a legal report on the reconstruction process (Cacace et al., 2012). Several universities from all over Italy contributed to the redaction of the Reconstruction Plans (§Ch.5.3) while GSSI organized 3 public forums for discussing the ongoing reconstruction. The outcomes of those discussion fueled additional research involving GSSI researcher and doctoral students, whose results have been recently published (Coppola, Fontana, & Gingardi, 2018).

The Interministerial Economic Planning Committee (CIPE) allocated 100 million euros in 2012 for all the Crater's municipalities (CIPE, 2012c) to a Program for financing industrial and research sectors, by supporting local entrepreneurial activities characterized by a high level of innovation and good growth potential (Axis 1), and by promoting brand-new business in the large fields of innovative territorial development (e.g.: infrastructures and services for smart-cities; tourist enhancement; promotion of food excellences; research activities about building recovery techniques) (Axis 2). Funding was assigned only in 2013 (55 mln for Axis 1, 45 mln for Axis 2) (DM. 8 aprile, 2013); the most recent official monitoring (dated December 2016) refers that ≈61 mln euros have been committed, but only ≈12,7 mln euros have been spent and mainly in Axis 1, son on already existing activities (≈8,5 mln) (Struttura di Missione per il coordinamento dei processi di ricostruzione e di sviluppo nei territori colpiti dal sisma del 6 aprile 2009, 2017, pp. 15-16).

Between summer 2015 and 2016 a larger program was issued, shortly called "ReStart" (L. 125, 2015; CIPE, 2016): 4% of the annual budget for Abruzzo Reconstruction for years 2016-2020 (for about ≈219,7 mln euros in total) is devoted to a development program aimed at ensuring long-term positive effects in terms of exploitation of endogenous (territorial, productive and professional) resources with direct and indirect impact on employment and job market, increasing services for the well-being of citizens and companies. As officially declared by the Mission Structure (Struttura di Missione per il coordinamento dei processi di ricostruzione e di sviluppo nei territori colpiti dal sisma del 6 aprile 2009, 2018, p. 21), the "Restart" strategy has benefitted from the availability of very advanced studies and analyses carried out in the Crater: the Mission Structure report openly refers to OECD reports (OECD, 2009, 2013), the studies of the Minister for Territorial Cohesion (Cacace et al., 2012; Calafati, 2012; Oliva et al., 2012), and the Reconstruction Plans[226]. It would be interesting to

[226] No monitoring of ReStart Program is clearly released, but the official webpage of the program (http://sisma2009.governo.it/intervento/ricostruzioni/sviluppo/progetto-restart/, accessed on 20th June 2018) shows that only 2 out of 7 "sub-areas" are labelled as "in progress", dedicated to Culture (development of cultural potential for the tourist attraction of the Crater) and to Advanced International Education; other 5 (Entrepreneurial and Productive System – mainly for the renewal of historical centres, incentives for the return of economic activities in villages, strengthening of the industrial system –, Tourism and Environment for enhancing tourist attractiveness,

understand, in future, if he public reconstruction – so late compared to the private one – will be able to leverage of this new funding possibilities.

Changing institutional frameworks

The peculiar role of special and intermediary institutions and offices in charge of the reconstruction – "different but not divergent" between emergency phase and ordinary phase – is a distinctive factor in this recovery process: the state centralization of decisional powers and the emergency regime, particularly strong in the first year (Erbani, 2010, p. 5), have progressively left more space to regional and local authorities, showing a continuous re-balancing of responsibilities and roles (see Figure 84).

The role of municipalities (both as individual institutions and as H.A.) has been the main constant of the reconstruction process, crossing both the emergency and ordinary phase, nevertheless with different powers in the different stages. On the opposite side of power relations, the central government has represented the other pillar actor in managing the reconstruction, but evidently in a much more fragmented way, due to the political unsteadiness of the country leadership (since April 2009, six Presidents of the Council of Ministers were designed) and the reorganisation of powers between the Civil Protection and two different Mission Structures across emergency and ordinary phases.

Paradoxically, the appointment of President of Abruzzo Region as Commissioner of the Reconstruction, therefore an elected and permanent institution even if in the non-ordinary role of Commissioner – indicating the return of powers from the national government to the local level – was confined to the only emergency phase, while two "special" and "temporary" offices (USRA and USRC) needed to be created to support the "ordinary" management, but of course without decisional or planning powers that remain in the municipalities' hands[227]. Conversely, the damaged municipalities (especially the tiniest ones) couldn't have afforded the reconstruction process without additional technical, human and administrative forces (UTR), both from the point of view of management of the funds and projects (testified by the activities of USRC and UTR Offices) and in organisational and political terms. Encouraging inter-municipal and inter-institutional cooperation – through the clustering in HAs – was an attempt of significant innovation and a necessary step for coherently coordinating the reconstruction in such a scattered territory. Bridging "too many and too small" municipalities for fostering shared territorial scenarios to relaunch economically depressed areas unfortunately clashes with the Italian resistant rhetoric of identity and parochialism – clashes occurred also in Emilia's post-earthquake reconstruction, as described by Franz (2014). If on the one hand, a direct empowerment of small local communities and administration (and their mutual collaboration), is needed for avoiding a dangerous "other-directed

Research and Technological Innovation – such as DarkSide-20K Project –, Digital Agenda – an experimental optical networking for the public administration –, Governance and Monitoring) are still in preliminary or starting phase.

[227] The weak involvement of Chiodi (Commissioner and President of the Region) in the reconstruction has been openly affirmed in the majority of interviews, reported on media, and directly experienced by the author who participated in the design of reconstruction plans of HA 9 between 2011 and 2014. Quoting OECD report: "The institutional setting put in place after the earthquake, which envisaged the appointment of Commissioners for the reconstruction in addition to the ordinary administrations, was in place for more than three years. Such a long period of governance in the emergency appears to have somewhat hindered the dialogue between institutions and citizens, increasing distrust and preventing effective community participation to the decision-making process. The new governance approach set up by the central government in 2012 has established a clear path of transparency and information regarding the reconstruction that should contribute to restoring civil and social trust and increasing the efficiency of public spending" (OECD, 2013, p. 20).

reconstruction", on the other hand the strategy has appeared controversial in its implementation: the effective cooperation among central and local levels, and inside HAs is clearly questionable (HAs have no normative authority on single municipalities but are only temporary unions) *"and also because the ultimate juridical responsibility falls in any case on municipal administrations and their civil servants"* (Official from L'Aquila Municipality).
A symptom of this weakness is the internal fragmentation of HAs for what concerning the Reconstruction Plans: only three HAs have unitary plans planned by the same designers, and two municipalities even "switched" HA. Ultimately, even when the Plans proposed common projects for a larger territorial scale, they envision scenarios without any mandatory role, fading the unity achieved and limiting full exploitation of the cognitive and experimental value of the Plans, which were often the outputs of large research activities or academic collaborations[228]. Even in the case of Umbria-Marche reconstruction after 1997 earthquake, the relevance of the social and economic components beyond the physical recovery has been under-considered, lacking social and political measures to sustain the repopulation and redevelopment of the affected settlements (Menoni, 2014, p. 76). The scale at which economic and social trends occur are not only local, and therefore need regional development strategies to substantiate post-disaster reconstructions.

Interviews – Chapter 5

Engineer, Supervisor of the "Reconstruction Plans" Sector at USRC	USRC offices, Fossa - February 2016 and 10th March 2016
Former Council Member for the Reconstruction at L'Aquila Municipality, Official of the Ministry of Infrastructures	Superintendence for Public Works, L'Aquila - 27th July 2017
Architect, Director of the "Planning" Sector" at L'Aquila Municipality	Municipal Offices, L'Aquila - 26th July 2017
Engineer, Director of the "Private Reconstruction" Sector at L'Aquila Municipality	Municipal Offices, L'Aquila - 2nd August 2017
Architect, Coordinator of L'Aquila New Town Plan	Rome, 27th July 2018
Engineer, Proteo Associati Engineer Company in L'Aquila	Proteo Associati Offices, L'Aquila – 24th July 2018
Engineer, Consultant of USRA Technical Sector	USRA offices, L'Aquila - 3rd August 2018
Architect, Professor of Urban Planning at Sassari University	Proteo Associati Offices, L'Aquila - 3rd August 2018
Architect, founder of LAQ Architectural Atelier, Designer of IntraMoenia Project in L'Aquila	LAQ Atelier, L'Aquila - 19th September 2018
Researcher at CRESA Regional Centre for Economic and Social Studies and Research	Phone Interview – 21st September 2018

[228] Or the opposite: according to some interviewees the local university institution – both the University of L'Aquila and GSSI – weren't involved enough in the local activities and ongoing processes, also by their own will. "L'Aquila Urban Center" represented a disappointing science-policy collaboration, as confirmed by interviewees. The centre took its first steps in 2011, with an agreement between the City of L'Aquila and the National Institute of Urban Planning (INU); the Scientific Committee was established only in 2013, and in 2015 it was defined as a Cultural Association. The activities of the Urban Center have never taken off, due to infightings according to interviewees and media (http://news-town.it/cultura-e-societa/20606-l-aquila,-urban-center-giulia-tomassi-%C3%A8-la-nuova-presidente.html); after a long stagnation, a new president was recently appointed in May 2018.

CHAPTER 6

Discussion

Berkes and colleagues in 1993 stated that the recovery phase is the less investigated and understood part of the disaster cycle, a statement confirmed also by more recent literature (Chang et al., 2010; Cheng et al., 2015). The thesis has investigated how disasters have affected national and local policies and practices of intervention for reducing recurrent nature-related risks and foster innovation in the field, analysing the pre-disaster and post-disaster recovery phases of two Italian disasters: Genoa 2011 flood and L'Aquila 2009 earthquake. A preliminary discussion on case studies has been already outlined in §Ch.3.3, 4.4 and 5.5.

6.1 THE UNDERESTIMATED ESSENTIALS: ADDRESSING HAZARDS, EXPOSURE, VULNERABILITIES

As described in §Ch.1.1, nature-related risk (R) (Wamsler, 2014) is the complex interactive expression of a set of components customarily simplified in hazard (H), vulnerability (V), exposure (E), where (see Table 1, §Ch.1.1): hazard is the potential occurrence of a disruptive event, exposure refers to elements that could be adversely affected by an event, and vulnerability is described as the predisposition of exposed elements to be harmfully damaged. Natural hazards cause catastrophes when combined with vulnerable conditions and high exposure. Research on disaster risk has nowadays assessed the responsibility of human activities in exacerbating natural hazards, especially in urban contexts (Ambraseys & Bilham, 2011).
As expressed in § Ch.1.1, the author adopts Thywissen's position (2006, p. 39), and describes the relationship between these variables with the pseudo-equation:

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

Since seismic hazard is not reducible, the principal measures of intervention rely on increasing the structural resistance of buildings and infrastructures to quakes through anti-seismic building standards, applied in the building construction and restoration in earthquake-prone areas, given the knowledge of the local seismic hazard. On the contrary, hydrogeological risks have been addressed by attenuating hazards when possible, such as intervening on hydrographic systems or on unstable areas, mainly through hard infrastructures as dykes or channelling riverbeds. Flood risk reduction is still implemented mainly through actions focused on "controlling waters". Both for earthquakes and for floods, the main strategy was delegated to engineering technologies and resistance standards relegating risk reduction to a building question (§Ch. 4.4, 5.5). These methods are essential, but the lack of wider multidisciplinary strategic approaches – able to include even softer measures for risk reduction – and of their spatial attributes represent recognized weaknesses (Cremonini & Galderisi, 2007). Indeed, interventions for reducing risks require: adequate comprehensive risk analyses, multidisciplinary planning and projects, availability of financial resources in the long-term by securing funding, political will, social awareness of existing risks, and community participation to risk reduction measures. The concept of “disaster risk reduction” (DDR) and “disaster risk management” is grounded on these notions, moving from the concept of “safety” and “protection” (Reghezza-Zitt & Laganier, 2012, pp. 34-35; Matyas & Pelling, 2014, pp. 6-7), towards a multidimensional process of reduction on the components of risk, through the design, implementation, and evaluation of policies and measures. This shift is affirmed at international level as well: according to the Intergovernmental Panel on Climate Change, risk reduction “denotes both a policy goal or objective, and the strategic and instrumental measures employed for anticipating future disaster risk; reducing existing exposure, hazard, or vulnerability; and improving resilience” (IPCC Intergovernmental Panel on Climate Change, 2014b, p. 1763). Similarly, according to the United Nations “disaster risk reduction strategies and policies define goals and objectives across different timescales and with concrete targets, indicators and time frames. […] These should be aimed at preventing the creation of disaster risk, the reduction of existing risk and the strengthening of economic, social, health and environmental resilience” (General Assembly of the United Nations, 2016, p. 16). The influential notion of resilience (§Ch.2.2) has indeed a relevant position in the debate on risk reduction; the Intergovernmental Panel on Climate Change defines resilience as “the capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation (IPCC Intergovernmental Panel on Climate Change, 2014b, p. 1772).

As described in §Ch.3.1, the Italian territory is inherently fragile: recalling data in Table 3 (§Ch.3.1), about the 16 municipalities with more than 200.000 inhabitants, more than 5 million inhabitants live in areas with high seismic hazard, 86.000 in areas at high/very high landslide risk, 236.0000 in areas at high flood risk. The reduction of risks by firmly addressing also vulnerabilities and exposure is still partial in flood-related interventions (Alfieri, Feyen, & Di Baldassarre, 2016; interview at CIMA foundation), and it is still mainly focused on addressing building-scale vulnerabilities while constructing new buildings in seismic-related interventions, underestimating the urban scale and the necessity to implement prevention measures (Di Salvo et al., 2012; Valensise et al., 2017); the reduction of exposure is almost considered “irreducible” in both seismic and flood risk-prone areas, since it mostly would interfere with property rights, requiring spatial transformations or land-use changes, above all in built urban environments. The focus on hazards underestimating exposures and vulnerabilities represent a tendency and a limit of risk analyses as well: such focus consequently push towards “structural, hard” measures of intervention leaving no space for other mitigation and adaptation measures on the one hand; on the other hand, risk analyses are difficult to be translated in ordinary planning strategies shaping land-use changes and risk reduction measures beyond the typical “prohibition of intervention” outside the boundaries of hyper-technical expertise (Galderisi & Menoni, 2007, pp. 20-21). It’s therefore manifest that an effective reduction of risk by lowering hazards through widespread interventions is neither achievable nor sustainable in the long term (Schanze, 2006), not only in the name of scientific accuracy and technical innovation, but also because it requires unbearable financial resources especially given the economic fragility of Italy. Besides, design solutions for hydraulic infrastructures are often bounded to no more adequate pluviometric parameters or return periods (Bisagno floods don't meet the estimated return times, flooding more frequently, as in §Ch.4.2, 4.3), above all in a non-stationary climate (Silvestro et al., 2016; interviews at Liguria Region and CIMA foundation), weakening the full effectiveness of infrastructural projects. Uncertainties about hazards and return times involve somehow seismic risk as well, as demonstrated by: the 2017 earthquake in Abruzzo which strongly affected 12 municipalities already damaged by 2009 seismic event (§Ch.5)[229]; the variation of Italian seismic classification between 1984 and 2003, review pushed by the 2002 earthquake in San Giuliano di Puglia[230] which was classified as non-seismic area at the time (§Ch.3.2); even the impact of the earthquake that struck Emilia in 2012 was worsened by long-time accumulated underestimations of the seismic risk in the area (Guidoboni & Valensise, 2014b; Tralli, 2014).

Urban development paths, planning and governance choices, on the contrary, can exacerbate the three components of risks, as shown by the widespread ordinary over-exploitation of natural resources, land and river beds. An investigation of Liguria Region about its "*demanio idrico*" revealed more than 300 buildings realised inside fluvial areas and riverbeds, including public buildings, and local authorities often still consider "covered rivers" as "safe rivers" nevertheless the well-known hydrogeological risks and ask to waive to building distance standards from riverbeds for facilitating development projects. As also Casagli and Menoni recognized, problems of inadequate implementation of the legislative frameworks – even if outdated or needy of revisions – have contributed to worsening the territorial fragility in its physical and social aspects (Menoni, 2005, p. 161; Casagli, 2012).

6.2 WAITING FOR THE-DAY-AFTER: REACTIVE AND PROACTIVE APPROACHES TO RISK REDUCTION (LOOKING FOR RESILIENCE)

Disasters are here interpreted as the harmful outcome of pre-existing longstanding conditions of risk involving environmental, economic and social elements of a given community: they are not instantaneous occurrences (R. Olshansky & Chang, 2009, p. 208). The notion of "disaster cycle" refers to a "circular" path because recovery strategies should dovetail into the next round of mitigation and preparedness activities (Pelling, 2003, pp. 13, 25; Paul, 2011, p. 157). Firstly, post-disaster recovery is a multi-dimensional process that bridges somehow all the phases of the cycle, both times of peace and times of emergency, since reconstructions should lay the foundations for reducing future risks and improving resilience in risk-prone areas (Figure 98). Secondly, disasters act as catalysts for change in policy processes, otherwise relatively stable (Johnson et al., 2005, p. 564; Manyena et al., 2011, p. 419), mobilizing larger numbers of actors and wider economic resources (compared to non-emergency phases) on a socially and politically tangibly recognized problem.

[229] The 2016-2017 seismic sequence was strongly perceived in L'Aquila, and had a "reminder effect" on the local population, "assuring" that the earthquake doesn't come every 300 years (see §Ch.6.2)

[230] A teacher and 27 children were killed by the collapse of the local public school.

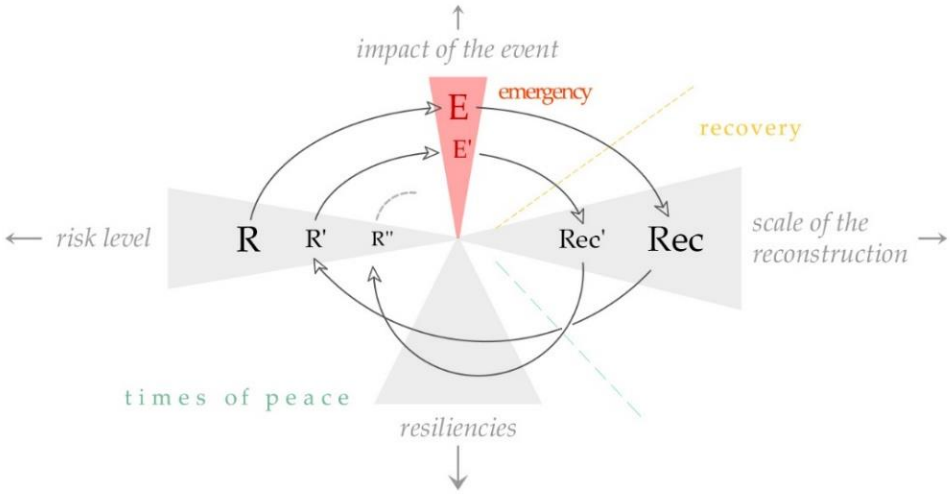


Figure 98 (figure 5 in §Ch.2.1). Risk (R), Shock Event (E) and Recovery (Re) as idealised by the author according to the disaster cycle in conditions of recurrent risk.

As emerge from §Ch.3, the normative evolution addressing nature-related risks in Italy demonstrates the role of disasters as triggering events for legislation updates, as depicted in the theoretical framework in §Ch. 2.1. This demonstrates also a strong tendency to a "reactive" approach to risk reduction, understanding "reactive approaches" as feedback-driven tactics (see note 68). In fact, the introduction of new legislation, commissioners and ad-hoc mission structures at national scale has always followed main ruinous events on the wage of the subsequent emergency, nonetheless Italy is a risk-prone country where nature-related disasters can be defined as "recurrent" at a national scale, and even at local scale in specific areas as Liguria Region or L'Aquila's Province (which experienced 3 disruptive earthquakes in a century in 1915, 2009 and 2017). This reactive approach is traditionally predominant, intervening *after* the disaster, *where* the disaster happened, and restoring the *damages* firstly. On the contrary, proactive strategies, understanding them as feedforward-driven approaches based on anticipation and adaptation and which look at the reduction of risk as a combination of hazard, vulnerability and exposure levels (see note 68), are rarely traceable. If clearly a world without disasters is not achievable – and reactive measures and policies are needed and unavoidable for planners and governors – proactive approaches are able to build holistic strategies of intervention before a disaster for minimizing the adverse impacts and facing the longer-term challenges of risk reduction, especially for climate-related hazards (O'Brien et al., 2006; Vale, 2014). In dynamic and unpredictable systems – such as urban environments exposed at high risks – the ability to cope with uncertainty and optimize feedback loops for enabling learning, adaptation and innovation calls for an additional focus on pro-active planning building on the complementarity of it with re-active solutions, currently still predominant (Wise et al., 2014).
The prevalence towards a reactive approach emerges also from the case studies here addressed, where the investments are mainly planned *after* and *where* the calamitous event stroke: the experiences of L'Aquila (§Ch.5) and Genoa (§Ch.4), cities clearly aware of the risks involving their urban environment, demonstrate the difficulty in metabolizing risk reduction as ordinary activity of the urban governance, from a technical, institutional and cultural point of view. The large works ongoing in Genoa for the reduction of Bisagno's flood risk are the legacy of infrastructural projects defined after the 1990s floods and meditated since the 1970

disaster. Nevertheless the evident engagement of the city in risk reduction activities[231], Genoa's risk is still very high. As openly affirmed by an official of hydraulic works sector at Genoa Municipality: "if the September storm that struck Livorno had occurred here in Genoa[232], I dare not imagine what would have happened". Regarding seismic risk, the vulnerability of the Italian building stock is very high in several areas of the country: it is analysed by academic research (e.g.: Valensise et al., 2017), proven by the national history (§Ch.3), and testified by the damaged occurred in L'Aquila also in recently renovated buildings[233]. The case of L'Aquila showed as the seismic risk reduction has been translated mainly and massively as just building safety, while seismic risk reduction gained some attention in the planning instruments only recently, while the reconstruction was in progress.

Recalling what introduced in the previous paragraph (§Ch.6.1), the notion of resilience entered strongly in disaster studies.
The "resilience" component evokes both the interrelated behaviours of the systems involved in nature-related risks, both the ability of those same systems to respond (or not) to the hazard (Vale, 2014). Proactive approaches appear as *theoretically* closer to the last definition of risk, refusing emergency interventions as main modus operandi and more anticipatory-oriented, able to better engage the notion of resilience in risk reduction strategies and policies. The engagement of local authorities in ordinary planning and design activities and inter-institutional cooperation are necessary for balancing long-term policies and priorities with short-term political programs. In contemporary cities affected by nature-related risks, coherent paths of intervention able to bridge short-term actions addressing urgent risks with the definition of long-term adaptation policies appear as a vital necessity (Zevenbergen et al., 2008; Rijke, 2014). It's necessary to stress that positive upgrades and advances are indeed introduced as reactive responses. As shown in §Ch.3.3, the Italian normative frameworks for risk reduction gained strength and detail after each disaster; on the other hand, the advancements achieved have probably not triggered appropriate "anti-silos" connections between regulatory frameworks and operational tools needed for a fostering a culturally innovative interpretation of risk – and of resilience, consequently. Indeed, risk reduction is still often a slipping topic between civil protection, planning and environmental protection fields in the country.
The national scale offers three interesting attempts to overcome the reactive paradigm, strengthening prevention activities and integrating directly or indirectly the notion of resilience in guidelines and criteria. The "Guidelines for the planning and design of interventions" realised by the Mission Structure against hydrogeological instability and for the development of water infrastructures "ItaliaSicura" (§Ch.3.2) in 2017 show an innovative approach addressing elements as the "risk assessment and management criteria" of the intervention, the comparative evaluation of different options through benefits/costs analyses, the definition of ex-post effect on natural and human systems, even requiring a description of the "resilience of the intervention" (Menduni et al., 2017). The "funding procedure"

[231] A list is available at http://www.comune.genova.it/cantieri/elenco

[232] Between 9th and 10th September 2017 a violent rainfall hit the city of Livorno (Tuscany), causing the flood of Rio Maggiore stream – detention basins couldn't retain the flood – and the death of 9 people. In the same hours, Genoa authorities had declared the "red alert", the maximum warning level.

[233] The Student Hall of L'Aquila University was built in the '60s and collapsed during the 2009 earthquake, killing 8 students. All the investigations and sentences of the trial for the Student Hall (started in 2010 and closed in 2016), have affirmed that the collapse was due to inappropriate works executed in the building and that an earthquake as 2009 one, given the seismic classification and history of the city, was "neither unpredictable nor exceptional".

established by ItaliaSicura in 2015 represented an attempt towards a proactive prevention strategy for the reduction of hydrogeological risks based on a "rewarding-approach policy": on the one hand it enforces an array of technical weighted criteria that expanded the concept of risk reduction, including the evaluation of post-intervention of residual risk and the role of non-structural measures (DPCM. 28 maggio, 2015), and on the other hand the formula compels territorial authorities (Municipalities, Regions and Basin District Authorities) to a direct engagement in designing prevention interventions in order to access state funding. The ranking of the accepted projects is indeed interestingly related to the level of definition of the projects (from preliminary to executive projects), and their implementation phase, including the finalization of required agreements with other institutions.
The SismaBonus Campaign (§Ch.3.2) attempts to promote a preventive large-scale program for structural strengthening and reducing seismic vulnerabilities, but again at the building scale, in the private sector mainly, and without any institutional coordination[234]. The bonus offers tax-break incentives to owners, proportional to the relative upgrade induced by the retrofitting interventions. The procedure requires an initial evaluation of the pre-existing seismic risk of the building. No data are available about the recourse to this bonus, but the requests do not seem very widespread in the country because of procedural difficulties, inadequate economic resources on the part of owners, scarce awareness of both owners and professionals about the bonus implementation; nevertheless, it is still praised as a strategical tool with wide potential of application in the future years (Centro Studi Consiglio Nazionale Ingegneri, 2018; D'Angelis, 2018, pp. 76-77)[235].
The 2017 Stability Law (L. 232, 2016, point no.460) enforces a new use of fees deriving from building permits: these resources should be used exclusively for urban and landscape maintenance and regeneration works. The law quotes (among other works) "interventions for the protection and requalification of the environment and the landscape, also for the prevention and mitigation of the hydrogeological and seismic risks"[236] and "expenditure for the design of public works".

Lastly, two essential factors able to influence local resilience emerge from the cases, both belonging to "times of peace" and not to "emergency phases": the importance of ordinary design activities for risk reduction – discussed further, §Ch.6.3 – and the role of preparedness. In the case of Genoa, the role of weather forecast and alert system for reducing flood-related losses is finally fully acknowledged. No forecast activity or alert system is viable for seismic risk: the preparedness of both local authorities in terms of prevention and response, and the inhabitants' knowledge about self-protection measures and correct behavioural practices is fundamental for reducing potential harms. As suggested by an interviewee at Cima Foundation, preparedness could be imagined as "a community deal about risk": everyone takes its own responsibilities established in advance, assuming awareness of the irreducible residual risk as well. So, nobody (neither the administrators nor the citizens) can say "I didn't

[234] In December 2018 a group of academics and experts in the field of seismic risk reduction have launched a campaign for highlighting strengths and weakness of the SismaBonus policy, asking: a greater commitment and responsibility of public authorities; a strengthening of exchanges between public actors and scientific community for fully exploiting the available scientific knowledge; a reformulation of priorities and urgencies for allocating funds, and the establishment of a clear monitoring systems (Chesi et al., 2018).

[235] The current Ministry for Infrastructures (Toninelli, Movimento 5 Stelle) confirmed the interest of Conte Government in ameliorate and confirm the SismaBonus introduced by Renzi Government (26th September 2018, introduction to the "National Day for Earthquake Prevention", available at https://www.youtube.com/watch?v=J3xQZYUiWdc)

[236] This norm recalls Liguria Region no. 41/2014 (§3.2)

know". The engagement of citizens is instrumental in augmenting city resilience and improve disaster risk management practices (Faccini et al., 2018, p. 239).

An author's direct experience is here described for recalling how the seismic sequence that shook Abruzzo on January 2017 caught L'Aquila off guard[237] – without underrating the efforts of national and local Civil Protection authorities in fostering events and programs for raising public awareness on nature-related risks. After the third quake, the rector of GSSI suspended all the activities; the Prefect of L'Aquila imposed an immediate closure of all public buildings for two days[238], and therefore GSSI buildings were evacuated[239]. The closure of functioning public buildings in L'Aquila – which had to be perfectly anti-seismic because rebuilt or restored after 2009 earthquake – even if set because of procedural praxis and for allowing inspections, gave a message of uncertainty about building security because indirectly evoked the notion that private houses were safer than public structures. Some colleagues of the author spent the night in a primary school equipped as emergency shelter by the local Civil Protection. On 26th January (eight days later), the Rector Office forwarded some practical information about "how to behave in case of earthquake": even if GSSI had organised a "Safety Course" on May 2016 following a request of its students (demand issued after a series of quakes occurred in January 2016; the author was among the petitioners[240]), the first flyer on the topic was issued by the institute only after the last seismic crisis. The Mayor of L'Aquila suspended again the teaching activities between 28th and 31st January because of another weaker seismic sequence whose epicentres were close to the city. In this case, both GSSI and the University of L'Aquila, certain of the safety of their own buildings, suspended the lectures but took the responsibility of keeping the buildings open, offering a safe place to their users if needed[241]. Anyhow, the new suspension of didactic activities asked by the Mayor reinforced the concerns of students who questioned what were the "safer" places: their houses or their working places? A large debate and bottom-up protests about schools' vulnerability took evident strength in the city,

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[237] The author was not in L'Aquila in January 2017: the events have been tracked through the official communication received through GSSI All-Users mailing list, friends' and colleagues' stories collected in the following weeks, local media.

[238] The closure was later extended until 21st January: http://www.prefettura.it/laquila/news/Comunicati_stampa-5469153.htm

[239] A lesson of the Urban Studies program was moved to a primary school: https://twitter.com/michelelancione/status/822213963257675776

[240] *19th January 2016, 10:52 am. "To the Director and the Direction Office. Good morning, given the seismic activity ongoing in the city since yesterday, we would like to ask if it would be possible to spread a vademecum about the correct behaviour in case of an earthquake, in terms of personal protection, identification of safe places in buildings, emergency exit, and so on. The knowledge of which actions to perform and which ones to avoid is not as widespread as one might imagine; it often depends only on having already experienced similar experiences in the past. Angela and I could test it simply by chatting with some colleagues on the bus towards GSSI. We believe that spreading risk awareness and good safety practices is important for everyone, especially for students who do not speak Italian and who could experience even bigger difficulties in case of emergency (particularly if they were not inside GSSI buildings). Thank you, sorry for the trouble! Best regards, Angela and Grazia".*

28th April 2016, 1:20 pm. "Dear All, to follow up the requests made by some PhD students, the GSSI has organized a Safety Course in English regarding seismic risk, preventive and protective measures and many other issues. Here attached you can find the program of the seminar. It will take place on May 6, 3 p.m. in the main lecture hall. For any additional information, don't hesitate to contact us. King regards, GSSI Directorate Office".

[241] *28th January 2017, 7:52 pm. "Dear All, because of the weak seismic activity in progress these days, the Mayor of L'Aquila has suspended the teaching activities in all the educational institutions up to Tuesday, January 31 as a very precautionary measure. Understandably, some of you got concerned with the situation, especially given that also the University of L'Aquila has suspended its didactic activities (although the University itself and its buildings remain open). The GSSI will remain open as its buildings are safe and have been inspected. However, reluctantly, we decided to suspend the classes scheduled on Monday and Tuesday not to force students to be here against their will. All lectures will restart regularly from Wednesday, February 1. Kind regards, Eugenio Coccia"*

starting from the case of Cotugno High School that suffered partial damages after the quakes and became the symbol of students and parents' mobilization (initiating also a verbal crossfire between the Mayor Cialente and the Chief of the National Civil Protection Curcio)[242]. Like GSSI, the University of L'Aquila experienced similar risk-related communication difficulties in the same period: indeed, the University defined a "Plan for Seismic Risk Communication" on April-June 2017[243]. According to several interviewees and sources[244], the inhabitants of L'Aquila understood that "the earthquake does not occur every 300 years" only on 18th January 2017, Ph.D. students included.

6.3 LOOKING CLOSELY: THE LEGACY OF THE PAST QUESTIONS THE POST-DISASTER WINDOW OF OPPORTUNITY.

As described in §Ch.2, "policy windows of opportunity" open up in critical times facilitating policy change and innovation (Kingdon, 1995) especially in case of public recognition of the problem and of political and institutional receptivity to the problem and to its potential solutions (Johnson et al., 2005, p. 565). In policy studies and disaster studies, the "after-shock window of opportunity" is influenced by the acceleration of the decision-making process, the increased social and political awareness, the enlargement of actors engaged in the debate, the non-ordinary economic resources. Post-disaster environments show a spatial and temporal compression of decision-making process, exacerbating the tension between "speed" (the pressure for quickly meeting post-event urgent needs) and "deliberation" (including the quality of the choices in terms of efficient planning and deliberation) (R. Olshansky & Chang, 2009; R. B. Olshansky et al., 2012; Platt & So, 2016): to "do something" may be more politically profitable than waiting for more cautious, effective and valuable deliberation (Birkland, 2006, pp. 7-8). The effect of the "time compression" and the tensions between speed and deliberation influence the post-event policies likewise. Disasters do open "policy windows" – above all in case of casualties (confirmed by interviews) – which can offer the potential for policy changes, but the policy response is generally guided by urgency and oriented to *exploit* all the knowledge rapidly accessible. Consequently, if existing strategies, rules or projects are available at close hand after the event, they may be used immediately even if inadequate.

The cases here analysed – Italy as country-scale case study, Genoa and L'Aquila as city-scale case studies – demonstrate on the one hand that the catastrophes act as triggering events for fostering some normative transformation and putting in motion renewed decision-making processes; on the other hand, the legacy of pre-event tendencies, beliefs and plans influences post-event choices strongly, that do not appear anymore as "emergency solutions" or "brand-new reconstruction/ redevelopment processes", nevertheless the political claims. The risk is that, when a window of opportunity opens, the public choice will turn towards the *available* and *feasible* solution option, and not towards the *appropriate* one, as described below.

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[242] http://news-town.it/cronaca/14661-le-scuole-dell-aquila-sono-sicure-il-caso-del-cotugno- agibile-ma-vulnerabile.html

[243] The author was kindly allowed by the Rector of the University of L'Aquila Paola Inverardi to assist to the first work meeting for the definition of the Plan in April 2017.

[244] As described also by Chiodelli (2017), professor at GSSI.

The norms, the plans, the projects: missing ordinary design

Norms can impede innovation, in “times of peace” and paradoxically also in “times of war” nevertheless the “state of emergency” allows extraordinary procedures, reducing the possibility to fully exploit post-disaster reconstructions.
The causality-nexus between damages and compensations described in L’Aquila case exists also in the domain of post-flood reconstruction: as confirmed by experts, damages are *restored* (physically and economically) after floods; without an active engagement in risk reduction activities – that could be contemporary to the restoration works – the risk level do not decrease[245]. Although the causality-nexus acts as “controller” of public expenditure, the inconsistency remains, letting budget control prevailing on the “consistency-nexus” between design and strategies. L’Aquila case (§Ch.5.5) showed as the normative framework de facto induced the restoration of pre-existing urban fabrics, limited the weight of the Reconstruction Plans and the transformative potential of the reconstruction process – cost almost 18 billion euros (Chiodelli, 2018) – even to the detriment of i. innovation chances at urban scale (e.g. urban recovery programs inside L’Aquila Reconstruction Plan); ii. safety levels at building scale (e.g. the trade-off between safety and conservation, the difficulties for realising voluntarily demolitions, or the possibility of non-compliance of listed building heritage with anti-seismic standards).

Norms seem to affect also technological innovation, especially for hydraulic works. In Italy hydraulic works for reducing floods need to resist to flow rates with T= 200 years: design solutions able to face milder floods to be combined with additional complementary interventions (e.g. for building “hydrophilic” urban fabrics), cannot be easily implemented, and higher return times require even more expensive and complex solutions. On the contrary, the available knowledge allows to build and evaluate “what if scenarios” and vulnerability patterns: “We still design as 50 years ago” (interview at Cima Foundation, §Ch.4.4). Investing in building resilience is vital because infrastructures aren’t sufficient anymore for reducing risks. A study of Cima Foundation kindly showed to the author displayed that the works currently ongoing in Florence area for reducing the flood risk (based on a system of detention basins and a dike, financed by ItaliaSicura) seem to reduce the expected impact of a flood comparable to 1966 event only *minimally*. Even if these interventions anyhow have a positive impact on the reduction of risk, Florence will not be “safe”: other structural and non-structural measures (as Civil Protection operations) are instrumental for reducing the damages to people and assets in the city.

Accumulated praxis and legislation bounds are associated with another critical element emerging from the cases: the chronic deficiency of ordinary programming and design of public works for risk reduction – often combined with an accumulated delay in their implementation. This problem has been illustrated in the Parliament in 2017 (Commissione VIII Ambiente Territorio e Lavori Pubblici, 2017) and ItaliaSicura’s activities (§Ch.3.1) of data collection and analyses about hydrogeological risks and the economic and technical needs of local bodies for investing in risk reduction demonstrate the national-scale of this issue. The engagement of ItaliaSicura structure in the “Design Fund” for supporting design activities was grounded on this structural necessity. In fact, the “National Plan of public works for reducing

[245] “Paradoxically, risk could even increase as effect of the augmented economic value of restored assets” (interview at CIMA Foundation).

hydrogeological risks" issued by ItaliaSicura counts only 1.089 projects ready to be implemented ("*progetti esecutivi*"); 1.483 cases can rely on advanced projects ("*progetti definitivi*"), while 6.800 are based only on preliminary project or a feasibility study ("*progetti preliminary*" and "*studi di fattibilità*") equal to 73% of the National Plan for 20,7 billion euros (Struttura di missione contro il dissesto idrogeologico e per lo sviluppo delle infrastrutture idriche, 2017, p. 530).
There is an underlying problem: funding the advanced design of a public work without the availability of financial capitals for ensuring the *realization* of the intervention is quite difficult for a public institution. This problem has been openly stated in several conferences organised by ItaliaSicura and confirmed by numerous interviewees: why designing if you cannot realise the work, risking wasting public resources? Institutions generally carry on only preliminary projects needed for activating the calls for tenders, assigning advanced design and implementation to external subjects. These praxis and bounds are related to the "general principles of public accounting"[246], such as the "principle of economy" of Public Administrations' actions (L. 241, 1990, art. 1) or the norms stating that "local authorities can incur costs only if the spending commitment and the attestation of financial coverage for those costs are already verified in the forecast budget" (DLgs. 267, 2000, art. 191). Even two resolutions of the National Agency against Corruption (no. 125, 9th May 2007 and no. 19, 18th February 2015) indicate that "the design of a public work cannot constitute a stand-alone activity, free from the execution of the works": a contract for the design of a public work cannot be awarded without the budget availability for its realization. The new Code for public works (DLgs. 50, 2016) seems to distinguish differently and more independently the design phase and the implementation phase of public works (Karrer & Pasanisi, 2016).

According to the author, conflictual norms and accumulated delay in programming and design works for risk reduction explode in case of a disaster. As stated above, post-disaster urgency tends to exploit pre-existing scenarios, plans and projects, because of envisioning transformative patterns is an arduous task in political, scientific, economic, and social terms, above all in post-catastrophe contexts. What if there are no scenarios, plans or projects to rely on?
The absence of projects increases the risk: not only it hinders the fundamental goals of promoting public safety and reducing nature-related risks in preventive terms (since more wisely you work in times of peace, the less you'll need to rebuild after), but even affects the recovery paths, that cannot rely on pre-existing (hopefully well-studied) strategies of interventions, and therefore the risk of wasting the post-disaster window of opportunity is truthful. In Genoa, post 2011/2014 flood interventions are based on post-1970 flood studies and projects. In Abruzzo, the limited extensions of the Reconstruction Plans contained inside the historical centres' borders, together with the absence of updated planning tools, have allowed to foster expensive town-scale reconstructions on almost a "spatial tabula rasa" in planning terms, above all in the minor municipalities of the Crater[247]. The hyper-local scale of building reconstruction devours the urban question in post-earthquake reconstructions; weak urban programming and planning affect as well hydrogeological risks, where the "right scale of intervention" should be the scale of the phenomena, and not the scale of the project. The outdated norms, the inertia of praxis, the missing ordinary planning and design of public

[246] They are based directly on the Italian Constitution, such as articles 81 and 97.

[247] The lack of a large-scale scenarios to support the reconstruction has been critically stressed also regarding Friuli post-earthquake recovery (Nimis, 2009, p. 100).

works and the accumulated delay in their initial programming and final implementation create a dangerous vacuum for a fragile country.

6.4 BUILDING RESILIENCE: RISK REDUCTION THROUGH PLANNING, GOVERNANCE AND THE SCIENCE-POLICY INTERFACE

Planning, and Civil Protection

Looking at the normative frameworks concerning seismic and hydrogeological risk reduction, on the one hand the evaluation and mitigation of hazards have been progressively included in national and regional legislation and the role of planning activities in challenging these risks is recognized, but on the other hand these themes are not present yet in cases of obsolete (but still in force) regional laws on planning. Attention to risk analysis and risk reduction is not granted in planning tools, either: as described by Galderisi and Menoni, risk-related competences are not fully integrated into ordinary planning, are "disaster-driven" and mainly limited the prevalent hazard (Galderisi & Menoni, 2007, pp. 20, 23). Recalling Manyena's "process-oriented" conceptualization of resilience (resilience as bouncing forwards: Manyena et al., 2011), risks need to be addressed holistically, and cannot be reduced – neither resilience can be increased – by addressing only single characteristics or components of risk. The relation between urban planning and reduction of risk emerging from normative frameworks has been based mainly on "assessments of compatibility" between proposals of future urban transformation and hydrogeological and seismic characteristics of the territory, assuming the knowledge of hazards (used wrongly as a proxy of potential risks) – inherited by other instruments as Basin Management Plans or geological surveys – as a guide for planning decision-making. Therefore, traditionally planning assumes risks as a "restriction" for land transformations. On the contrary, according to the interpretation of resilience aforementioned, risk reduction can be understood as a goal of planning, among the few discipline and practice that can aim for embracing the multiple systems composing the built environment and involving different spatial and temporal scales. Clearly, the traditional predict-and-control regime and current planning instruments still lack in flexibility, leaving small room for uncertainties and adaptive paths of transformation: on the contrary, especially in case of nature-related risks, pieces of evidence and uncertainties need to be both investigated and addressed by planning policies and tools (Davoudi, 2012, p. 439; Davoudi et al., 2012, pp. 304-305; Rijke, 2014; Hillier, 2017, p. 344). The ordinary engagement (and quality role) of urban planning in contributing to long-term risk reduction and adaptation, and planning positionality in the broad field of disaster risk reduction – both in technical and normative sphere – has been perceived as unclear for too long time (Menoni, 1997) and still is "not so clear", at least in Italy (Alexander, 2013a, p. 70; Menoni, 2014, p. 77). For instance, the relation among ordinary urban planning and emergency planning is a recent topic for the discipline (discussed below). This attitude is surprising, above all because in post-disaster contexts the need of integrated multidisciplinary planning contributions is recognised as a favourable strategy for reducing risks, maximising the collective efforts and decrease costs (see for instance the ambitious goals for post-earthquake reconstruction plans proposed by Law no. 77/2009 in §Ch.5). Instead, an effective reduction of risks through planning needs systemic multiscale strategies able to take into consideration the effects of territorial transformations on physical, functional, social and economic pillars of cities (Biondi et al., 2011; Menoni, 2014). Indeed the planning dimension can be able – both in ordinary management and in post-emergency contexts – to: i. forward breaches in the dangerous silos mentality that is inherent to the fragmentation of roles and responsibilities between disciplines and authorities in the field of risk reduction and adaptation (Menoni, 1997, pp. 241-242), moving towards an holistic interpretation of nature-related risks and consequently, ii. act as a common ground of connection and mediation between experts and actors. The complex and unapplied[248] L. 183 (1989) represented a large innovation in cultural terms, able to overcome administrative borders preferring the physical ones (the river basins) and to propose a multidisciplinary approach for land defence fostering inter-institutional coordination.

As recalled by Alexander in an evaluation of L'Aquila's reconstruction: "The resettlement policy in L'Aquila led to the replication of a number of problems that were encountered in other countries [...]. One was the importance of planning in an integrated manner for all stages of the 'disaster cycle': mitigation (risk reduction), preparedness (including prediction and warning), emergency response, recovery and reconstruction. In Italy there is a tendency not to plan and not to understand the purpose of planning, which should enable rather than restrict by coordinating the rational use of resources" (2013a, p. 70)[249]. The reduction of nature-related risks affecting existing urban fabrics (and often built in dissimilarity to regulations) is the most demanding challenge of the field and cannot be addressed only through case-by-case interventions carried on buildings or natural elements as specific streams or landslides. The spatial scale needs to be addressed for scientific and cultural reasons explained in this thesis, but also because the architectural and hyper-local scales are ineffective, as demonstrated for instance by the difficulties in implementing interventions in condominiums and building aggregates in L'Aquila, and the interventions in the Bisagno valley in Genoa, that are a large-scale complex system made of three main interventions (the rebuilding of Bisagno coverage and two floodways) integrated with a set of secondary works (maintenance of riverbeds, demolition of exposed buildings). The interference of risk reduction projects with public and private surfaces and property rights in unavoidable, that can find space of resolution in planning instruments: above all the most advanced methods of interventions require integrated approaches at the urban and territorial scales, and transformations of the built environment. For instance, dealing with hydrogeological risks, nature-based solutions for flood risk reduction require wide spaces and a redundant integration of soft and hard infrastructures; examples for seismic risk are the interventions on building aggregates in historical centres, which imposes coordinated projects involving portions of urban fabrics and not on single building units, or the incorporation of strategic

[248] The premises of Law no.183 required an efficient cooperation and coordination between local and supra-local authorities, planning scenarios and operational plans. Conversely, the highly fragmented universe of responsibilities, actors and scales of interventions in the realm of flood risks have slowed down the implementation of the Law, weakened the effectiveness of risk reduction strategies, made even more difficult the translation of knowledge and strategies into actual transformations at urban scale (Filpa, 2001, pp. 49-51; Brunetta, 2003, pp. 40-41).

[249] Enlarging these reflections towards prevention activities, it is necessary an annotation about the relationship between urban planning and the activities of prevention and emergency management, carried out by the Civil Protection mostly. This relationship was ruled by the L. 225 (1992) and imposing that local-level civil protection activities should be harmonized with the programs for territorial protection and recovery. A recent reform of the Civil Protection system (L. 100, 2012) has overturned this notion, imposing to plans involved in government and protection of the territory to be coordinated with the emergency plans of civil protection, above all with local ones (art. 3).

edifices and infrastructures for emergency management as categories for planning (e.g. S.U.M. and C.L.E., §Ch.3.2) (Fabietti, 2013; Olivieri, 2013).
This last example reminds that the planning domain and the planning scale have an innate relation with the activities of prevention and emergency management – carried out by the Civil Protection mostly – but the integration emergency planning in urban planning is a recent subject. This relationship was ruled by L. 225 (1992) imposing that local-level civil protection activities needed to be harmonized with the programs for territorial protection and recovery. The 2012 reform of the Civil Protection system (L. 100, 2012) has overturned this notion, imposing to plans involved in government and protection of the territory to be coordinated with the emergency plans of civil protection, above all with local ones (art. 3). Besides the regulations, it is evident that prevention and protection measures developed by Civil Protection corps are planned and implemented at urban scales, and the necessities of the spatial organization of emergency spaces could influence consistently the design of planning instruments. Lastly, it is important to highlight that projects of urban retrofitting can contribute to risk reduction by adapting cities to risks and decreasing the latter operating at the neighbourhood or micro-urban scale; such scale of intervention can better address those difficult – underestimated and not rare – cases of multiple interacting hazards involving the same urban environment. Often is a matter of resistance to break praxis and known technology the true barrier, and not the difficulty of intervening on the urban fabric

Governance and the Science-Policy interface: data and actors

A modern-day governance of urban spatial transformations – including planning activities – has the possibility of addressing nature-related risks in times of peace, recurring both to technological resistance-oriented approaches and to holistic resilience-oriented interpretation of risk reduction and adaptation.
The main causes of urban risks do not lie in technical or economic constraints in addressing and reducing risk components (although the true challenges related to the national and local resource constraints affecting the implementation of risk reduction activities): the roots are embedded in praxis and normative limitations, lack of design activities, implementation delays, precarious political engagement, weak science-policy effective interface. Quoting Scolobig: “the analysis of social, political, legal and institutional processes causing increased risk exposure and vulnerability has often been marginalized in research, at the expense of a focus on technical solutions and scientific analysis” (2017, p. 2). The role of “science and technology” is recalled also in UN Sendai framework for Disaster risk reduction, which calls for “facilitating a science-policy interface for effective decision-making in disaster risk management” (UNISDR United Nations International Strategy for Disaster Reduction, 2015, points 24.h, 25.g, 36.b). The science-policy interface – in particular in the field of research this thesis is addressing – is a complex two-way process, rather than a “transfer” of knowledge from science to policy (from the production of knowledge to its application and influence on knowledge recipients) (Spray et al., 2009, pp. 562-564) above all if such interface is devoted to promote “change”, innovation: the complex relations among institutions, available technology and knowledge, socioeconomic conditions affect the interface and its efficacy.
From the point of view of “*research and data*”, Italy does not lack research, statistics or information about seismic and hydrogeological hazards, even internationally acclaimed (Menoni, 2014, p. 78); nonetheless problems about availability, updating and usability of data and research results (but also about the “public demand” of such data and results) are clearly

raised by researchers and practitioners (Molinari et al., 2014). For instance, in the field of hydrogeological risk, pluviometric variables are manifestly changing and studies on the impact of climate change on hydrogeological hazards are a cutting-edge research field (Tous & Romero, 2013; Faccini et al., 2015). Besides, research and data are mainly hazard-dominated, while evaluations of risk as the product of hazard, vulnerability and exposure are not frequent, and the availability of open-access data at local scale is very recent (§Ch.3.1). The necessity of fostering more multidisciplinary research and experimentation for better reduce nature-related risks has been confirmed by interviewees in both the case studies (especially underlying the necessity of evaluating the social impacts of plans and interventions). Therefore, the "science" side of this interface is quite robust.
The issues about the "policy" side are clearer assuming a "*programmatic* and *organizational*" point of views, inspired by Wamsler (2014, pp. 57-58)(§2.1) and referring to strategies introducing dedicated programs for risk reduction and involving modification of policies and regulations. On the on hand, the criteria developed by ItaliaSicura for accessing the national funds and the related "design guidelines" elaborated involving practitioners and experts show an interesting attempt to "brokering knowledge" by securing funds and fostering a capacity-building oriented approach involving local and supra-local authorities, research makers and policy-makers. On the other hand, in emergency contexts as post-disaster reconstructions, the complexity of disaster risk-related science and research results risk to be poorly translated into short-comings and preferring "research-that-fits-in" for institutional constraints or "research-that-matches-the-beliefs" because of competing interests (also for not risking losing financial aids when available). As sketched in Figure 99, learning and innovation need time, that is a scarce and compressed resource in emergency and recovery phases of the disaster cycle (R. B. Olshansky et al., 2012), limiting opportunities for effective feedback loops for those institutional structures that should normally empower appropriate choices in the recovery phase aiming at combing change and continuity (Holling, 2001; Wise et al., 2014). Moreover, the "idealization of the past" in residents' minds versus the uncertainty of the future (e.g. the conflict between past and future plans described by R. Olshansky & Chang, 2009) is a force that cannot be underestimated, above all once we question the idea that the "previous state" is necessarily desirable and "therefore the collective action should be limited to restoring that state of normality" (Coppola, 2016, p. 138).

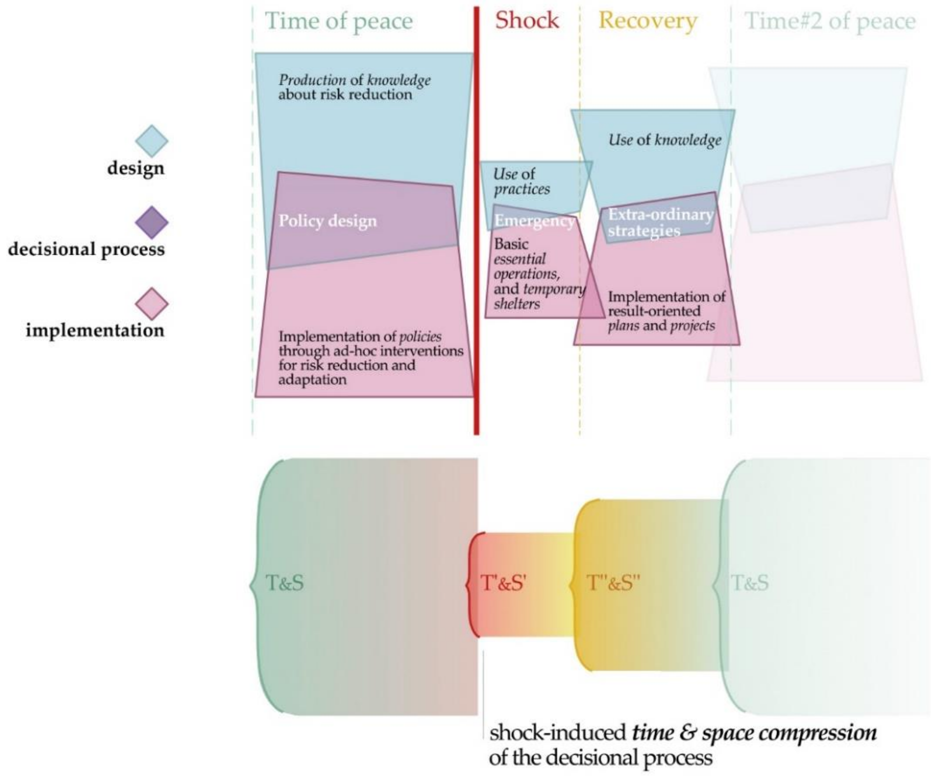

Figure 99 (fig. 7 in §Ch.2.1). The knowledge-policy interface adapted to the disaster cycle. Elaboration of the author.

The cases of Genoa and L'Aquila show some of the "short-comings for accumulated delay" and "time-compression symptoms" – without questioning neither the importance nor the technological innovativeness of the plans and projects in both cities (which is obviously not the intent of this work). The modality of intervention on Bisagno (through the reconstruction of the coverage and the realisation of the floodways) was chosen in the 1990s and confirmed until 2010s, also as a consequence of the accumulated delay and trials that characterized this history (pleas about the chosen option are traceable, see Rosso, 2014); the reconstruction of Abruzzo has clearly answered to the "as it was, where it was" mantra for the historical centres and, on the contrary, to the "urgency of sheltering" in the peripheries, postponing transformative projects as demonstrated both by the normative framework at it basis and by the use of the funds. The space for fostering science-policy interface seemed limited to technological upgrade of engineering solutions in both cases. In L'Aquila there was no political will of using the reconstruction phase for designing a new town plan. In Liguria interventions of building demolitions in areas at very high risks occurred only after the disasters, exploiting the social indignation and the rise of the debate in the local political arena. It's difficult to trace here programmatic or organizational long-term strategies from mainstreaming risk reduction, but – as mentioned above – the preference for "options-that-fit-in" in the pre-existing status quo.
The case studies are particularly interesting also assuming a "*interinstituional/cooperative*" perspective of analysis (Wamsler, 2014, p. 60), that refers to the cooperation among different actors for improving risk governance. Indeed, multiple actors participating in the decision-making process, and the very different time frames in which those actors are involved, represent a crucial aspect of the science-policy interface. In the case studies of this thesis, new forms of partnership and debate between endogenous and exogenous actors, and the reformulation of

responsibilities and transdisciplinary integration able to break silos mentalities and inertias have been triggered, successfully and not.
The investigation about Italian national scale (§Ch.3.1) reveals specifically a "breaking point" in the traditional reactive approach with the introduction of ItaliaSicura Mission Structure which, together with Law no. 116/2014 (L. 116, 2014) enrolling the Presidents of Regions as commissioner for hydrogeological risks, has forced local authorities to take action in the first place (therefore assuming the responsibility of the project and demonstrating awareness of the issue) for applying to national funds. Looking at Abruzzo's case, the weakness of Homogenous Areas and the lack of a provincial-regional scale coordination of the reconstruction, except for few cases, has resulted in clearly fragmented options of interventions, probably slowing and reducing the potential of the reconstruction process. The former director of USRC office underlined the significance of the Table of Coordination among the Crater's Mayors, for instance, suggesting reinforcing it[250]. Conversely, the "spinning role" of inter-sectorial and inter-institutional cooperation is here showed by the formation of USRC office for the Seismic Crater in the reconstruction process (even if only in terms of implementation of choices, not of definition of them). Both Liguria (with the closure of Provinces) and Abruzzo (with the introduction of USRC Office) cases suggest a question about the role of "intermediate bodies" and "territorial scales of intervention" for environmental issues. Could "intermediate actors" fostering both the scientific also political debate and coordination of activities for risk reduction, where the natural scale of the phenomena is often larger than the municipal borders, and smaller than the regional ones?

The science-policy interface stands also a cultural tool for fostering innovation in the long-term the field of risk reduction by minimising both the *technical-political gap* between researchers, technical officers and political representatives, and above all the *mismatch between the political and disaster risk cycles* recognised by the majority of interviewees and by literature as well (e.g.: Scolobig, 2017, p. 18). Interinstitutional cooperation, co-learning processes and science-policy interfaces cross all the phases of the disaster cycle, characterizing mainly the times of peace, but nurtured before a focusing event and implemented later, in the recovery phases. Theoretically, in times of peace, the science-policy interface can strengthen the efforts in prevention activities, making easier: the public participation in the definition of spatial transformation; the selection of the most adequate solutions; the experimentation of pilot projects. During recovery phases, the science-policy interface is here interpreted as spinning resource able to optimize the work done in time of peace: on the one hand, the past acts as reference that tends to re-propose itself and its inertias and vulnerabilities; on the other hand, the "enlarged network of actors-topics-human&financial resources" that arise after a catastrophe can move from those strategies and instruments – once they exist – and therefore is able to exploit the post-disaster window of opportunity, leveraging on the "accumulated" and "new" knowledge. Past paths can be questioned with more awareness, transparency and strength for influencing post-event choices – hopefully limiting negative outcomes – and forwarding capacity building in adapting to future risks.
Especially the case of L'Aquila shows the difficulties of implementing in practice an effective science-policy interface: there was – and still there is – a large mobilization of endogenous and exogenous research in the city and on the city, and the availability of conspicuous economic resources and renewed human resources, but the windows of opportunity for fostering long-term innovation seems too partially exploited. Referring to ItaliaSicura National Plans, criticisms about the lack of courage in promoting "innovative projects" and not only "projects" for risk reduction represents a valid issue for further reflections.

[250] http://www.usrc.it/home/multimedia/813-formiamo-il-territorio-la-fattibilita-della-ricostruzione-formedil-teramo-paolo-esposito

FINAL REMARKS

A “REVISED” DISASTER CYCLE IN THE LIGHT OF THE “WINDOW OF OPPORTUNITY” CONCEPT

The concepts of disaster cycle (Pelling, 2003) and of “post-disaster windows of opportunity” (Birkland, 2006; R. Olshansky & Chang, 2009) are relevant for both the case studies of this thesis. The research work moved from experts’ opinion that *reconstruction&recovery* is the less investigated phase of the disaster cycle (Berke et al., 1993; Cheng et al., 2015), and from the author’s interest in investigating post-event strategies of reconstruction as processes for increasing resilience in a country dangerously prone to nature-related risks and that can rely on a significant knowledge-base about risks. The thesis has firstly investigated Italy and Italian cities as a “national-scale” case study, and how disasters have affected (and not) national (and local) policies and practices of intervention for reducing recurrent risks and foster innovation in the field. Then, the research works focused on the pre-disaster conditions and post-disaster recovery phase in two cities exposed to severe risks and recurrent disastrous events: Genoa, struck by disastrous floods in 2011 (followed by another major flood in 2014), and L’Aquila, destroyed by an earthquake in 2009.
The cases are addressed mainly from the point of view of the planning and design strategies implemented before and after the events[251]: Menoni already in 1997 affirmed the necessity of planning activities for risk reduction during the “times of peace” of the disaster cycles – therefore in pre-impact phases – stressing that the most concrete results in reducing disaster risks can be achieved just in “ordinary management” (Menoni, 1997, pp. 108-109). Again Scira Menoni, in more recent times, underlined how the attention of urban planning scholars to the disaster cycle is rarely focused on “the entire time scale, and have generally privileged to analyse the post-reconstruction results or (rarely) the pre-impact phases, neglecting to study the emergency and especially the transitional recovery phases” (Menoni, 2014, p. 77).

The notion of “cycle” helps in pointing out the problem of the “time dichotomy” between the post-disaster political processes (oriented mainly towards short-time horizons for answering urgent needs) and the territories’ necessities (that need to be addressed also on longer-time horizons). The building of medium-long term resilience is a complex process that needs to bridge different temporal and spatial scales, involving a multitude of actors and interlocutors changing over time. This means that the efforts for promoting change and innovation after a disaster must be moved beyond the limits of “*agenda* change” – change that always follows a disruptive event – for substantiating into “*policy* change” for promoting ordinary resilience and risk reduction (Birkland, 2006, p. 2) – also reaffirming, clarifying or rearranging those risk causes and responsibilities which are too often “denied, buried in the past, or unfathomable” (interview at Genoa University). Shifting from “agenda changes” to “policy changes” is

[251] The educational and professional background of the author is in architecture and urban planning fields.

politically and institutionally challenging: as affirmed also by interviewees, the country needs risk reduction policies but instead the focus is still on “material interventions”. The definition of such policies is instrumental not only in prevention terms – also because “Risk Level Zero” cannot be reached, not even by large interventions and reconstructions – but also for not dispersing the capital of managerial, technical, academic and administrative knowledge accumulated after a disaster, by developing good practices of reference which can orient future actions. Otherwise post-disaster commitment remains just rhetoric, and never able to activate an effective risk reduction pattern. Referring to Olshansky and Chang’s work, planning for risk reduction activities – from activities in times of peace to post-disaster reconstructions – can therefore be defined as a “microcosm” of ordinary planning challenges, or better a “sped-up version of the normally difficult processes of urban planning” (2009) and, vice versa, “the exploded time and territorial legacies of a post-disaster city” (as in L'Aquila: Coppola, 2018, pp. 167-168) represent the macrocosm of crisis and potential of planning, above all in crossing short-term necessities and long-term legacies.

Disasters do act as catalysts opening up a “window of opportunity” for risk reduction (Alexander, 2013a) and for pushing towards innovations, but the aftermath of a shock is characterized by a compression of the (already complex) decisional process in *time* (many decisions need to be taken in urgency) and in *space* (the affected area is identifiable) (Platt & So, 2016). Such compression can lead more easily towards the maintenance of pre-existing status-quo because the conflictual and multifaceted interactions between normative, institutional, economic, social and political spheres are exacerbated in fragile communities and emergency contexts, and building long-term pattern of transformation are arduous to handle during crises. Indeed, as sharply summarised by Smith and colleagues: “Crises provide an opportunity for enhancing social learning and accelerated policy change (Johnson et al., 2005): it is those policies that are ready to be exploited during a window of opportunity and that are amenable to refinement […] that are prime candidates for adoption. […] If any stakeholders have different, or preferred, options, they would do well to prepare their case now, ready for the next crisis” (Smith et al., 2017, p. 14). Also according to Birkland, disasters foster “changes” *only* (unexpectedly) in case of high social attention and in case of peculiar accumulated knowledge: they rather reinvigorate pre-existing ideas and approaches (Birkland, 2006, pp. 173-183). On the contrary, reconstruction phases – since the resources invested – should be leveraged as processes aiming at reducing risks and promoting innovations for higher resilience in the future time of peace. Confirming the theoretical framework at the base of this research (§Ch.2.1), the cases addressed show that the work in time of peace is highly influential in shaping the re-action during and after a ruinous event, because pre-existing norms, projects and plans – and their absence as well – together with prevalent beliefs and values, affect also the post-shock phase and its recovery path, questioning the “window of opportunity” as triggers of technological and political change – or even as “window of *dis*opportunity”. The case of L’Aquila (and Abruzzo Crater) showed that the reconstruction both outside the historical centres and therefore the Reconstruction Plans, and within those them, has followed strictly the “*as it was, where it was*” mantra, both for normative and economic restraints on the one hand, and for the lack of other proposals of urban transformation to rely on or recall, on the other hand. The absence of updated town plans and building regulations, together with small-size local institutions (also weakened and overstressed by the enormous scale of the catastrophe)

reinforced the path-dependency[252]. The case of Genoa somehow recalls this same "*as it was, where it was*" mantra where the ongoing strategies for the reduction of Bisagno flood risk were basically defined twenty years ago – except for the needed technological updates – while other complementary interventions, as building relocations, were already well-known as essential but implemented only after that the flood impacts exposed their necessity as self-evident.
The post-disaster "emergency/extraordinary strategies" appear to be strongly dependent on the pre-existing norms, plans and policy design occurred before, in the "business-as-usual" periods: consequently, optimizing the science-policy interface in the reconstruction processes seems to deal with similar challenges, especially as shown in L'Aquila case were diversified collaborations among institutions, expert consultancies and research activities were mobilized, widely recognized, but poorly metabolized in the making-process of the reconstruction.
On the contrary, a continuous (and hopefully independent) science-policy interface represents a bulwark to the "mismatches between the political and the disaster risk cycles" (Scolobig, 2017); the brief experience of ItaliaSicura Mission Structure can be recognised as a first attempt towards a different paradigm. It's interesting how the theme of risk resilience was not so deeply debated by all the cognitive mobilization that followed L'Aquila's earthquake in the first years – but it has a distinctive space in 2017 ItaliaSicura's "design guidelines": these aspects suggest an entry point for further investigations about how urban resilience is translated in both preventive and post-disaster spatial transformations and guidelines of intervention.

Concluding, the cases of Genoa and L'Aquila show a prevailing "com'era dov'era" approach, *by law* (because norms impede innovation), *by money* (because resources compensate damages, primarily), *by choice* (because it's less conflictual, socially and normatively). In the conflict between the plan of the "past" and plan of the "future" while building post-disaster strategies (R. Olshansky & Chang, 2009), many opportunities for launching development projects and innovative plans and scenarios able to respond to latent needs are lost idealizing the past, those latent needs that could find an opportunity for resolution namely in the reconstruction (Menoni, 2014, p. 77). But then, as showed by Genoa case, "today" post-disaster choices are "tomorrow's" capital and legacy for reducing future risks and reconstructions. Therefore, also inter-institutional cooperation, co-learning and science-policy interfaces for capacity building in reducing risks and adapting to them must cross all the disaster cycle, characterizing predominantly the times of peace, for finding implementation later, in the recovery phases, and so forth, in the cycle. Clearly a virtuous "disaster cycle" can be broken by conflicting interests, or diverging cultural positions – as the well-known clash between conservative and transformative approaches – can impede to fully exploit the cycle. Recalling Figure 4 in §Ch.2.1, the disaster cycle should highlight how learning and capacity building should encompass all the phases (Figure 100):

[252] Giovanni Nimis is sharply critic towards some aspects of Friuli's post-earthquake reconstruction that represents the "genesis" of the "*as it was, where it was*" mantra: such "effective resolution, although partially enigmatic as totalizing and generic [was] the alternative against abstract and unreliable demiurgic proposals. [This approach was] reassuring, it begged the fear of being overwhelmed by uncontrollable transformations on one side, and by the terror of 'everything is lost' on the other, and it was converted into a real government slogan. If such pragmatism of Friuli model [...] allowed to avoid […] inconclusive discussions […], it is also true that its exasperated degree of realism didn't allowed to produce adjustments. [...] The suburbs rose more overwhelming than before thanks to the passe-partout of the reconstruction *in situ*, independently from any abstract, eventual, residual urban planning" (Nimis, 2009, pp. 16-19).

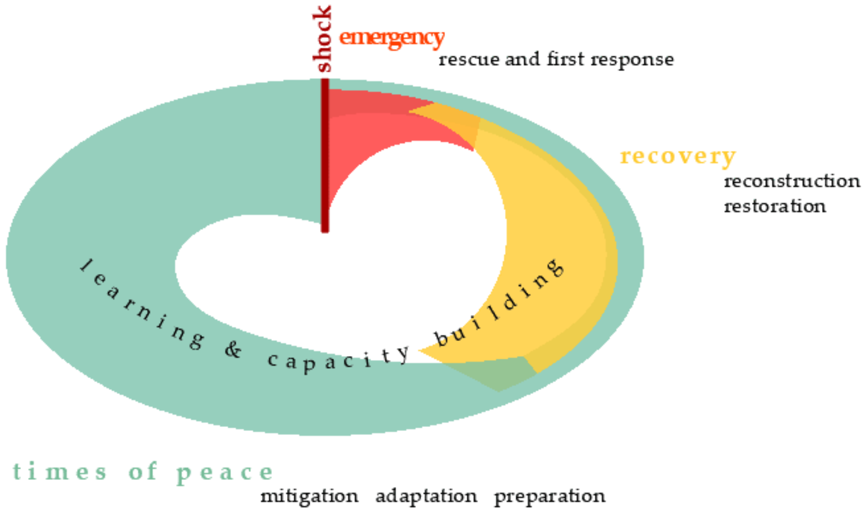

Figure 100. The disaster cycle revised. Elaboration of the author.

As stated by the international literature and explored in this thesis through case studies, the work in time of peace is precious not only as prevention activity for risk reduction reducing potential future losses, but also because it evidently affects even the post-shock phases, because the overcoming after-disaster "emergency/extraordinary strategies" are strongly dependent on pre-shock policies, design, norms, praxis. If research for risk reduction, ordinary project design and timely implementation lack in times of peace, there can be neither long-term prevention engagement, nor innovative solutions in critical phases: emergency policies are much less "extra-ordinary" than portrayed, guided by the "urgency factor" and the windows of opportunity will be lost, caged.

APPENDIX

Notes about nature-based solutions for flood risk reduction

FROM "AGAINST" TO "TOGETHER WITH" NATURAL FORCES

The expression "nature-based solutions" (NBS) has been object of several definitions in multiple domains: they generally refer to multifunctional complex interventions that lever on existing natural dynamics and ecosystems services – or mimic them – for addressing societal challenges (as climate change, or the reduction of nature-related hazards). As described by scientific and grey literature, NBS are expected to be multifunctional projects, able to address primary targets (such as flood risk or habitat restoration), provide added co-benefits for societal well-being (including recreational uses or aesthetical benefits) and improve – or not negatively impact – the ecosystems involved (European Union, 2015; Narayan et al., 2016; Pontee, Narayan, Beck, & Hosking, 2016; Wamsler & Pauleit, 2016). Examples of NBS are both the enhancement of ordinary infrastructures by introducing natural elements (such as sand nourishments for protecting dykes) or the use of only natural materials and processes (for example, mangrove reforestation for reducing wave height). NBS show the potential to maximise co-benefits and intersect multiple policy sectors and to be considered as particularly "resilient to changes, as well as energy and resource efficient" (European Union, 2015, p. 24), able to deal with uncertainty and complexity, shocks and stresses, by meeting multiple functions (European Union, 2015; Kabisch et al., 2016; Nesshöver et al., 2017) (§Ch.1.2).
Given the peculiar complexity of these living interventions, the planning, design and implementation of NBS indispensably require i) a multidisciplinary and multi-systemic approach, and ii) stakeholders' and institutions' large commitment in a non-silos governance, recalling the positions discussed at §Ch.6.1, 6.4. The interest in nature-based interventions for achieving economic, environmental and social benefits has been evidently increasing in the last 20 years (Chiu, Di Giovanni, Ashley, & Zevenbergen, 2017), fed also by the general awareness about the mutual interrelations and benefits between social and ecological systems (Adger, 2000; Pickett, Cadenasso, & Grove, 2004; Davoudi et al., 2012; European Union, 2015, p. 5).

In the fields of reduction of nature-related risks and adaptation to a changing climate, the experimentation of large-scale NBS represents an innovation in designing more sustainable risk defence strategies compared to traditional hard infrastructures. If forms of NBS aiming at reducing nature-related risks are already known – such as reforestation for reducing landslide risk or beach nourishments for counteracting coastal erosion – to take advantage of nature's forces instead of constraining them is a rather recent approach to disaster risk reduction. Coherently with the literature, the author refers here to NBS as complex engineering solutions which mimic or rely on existing environmental dynamics to address multiple environmental-related challenges and contribute to risk reduction. Even if NBS shouldn't be considered suitable for all risks and areas – "hard" engineering solutions are still often the indispensable

and most effective choices – their holistic tactic demonstrates important potential for adapting to extreme events addressing both adaptation and mitigation goals, merging structural and non-structural measures, while promoting a sustainable use of resources (§Ch.1.1,1.2, 2.1) (Cohen-Shacham, Walters, Janzen, & Maginnis, 2016; Kabisch et al., 2016; Pontee et al., 2016; Chiu et al., 2017; Nesshöver et al., 2017).
Traditional robust but rigid engineering based on strong standardized structural components doesn't appear anymore as the decisive approach to face increased climate-related risks. The sustainability of conventional engineering is challenged also in financial terms (questioning their cost-effectiveness along the life-cycle of the infrastructure, given the costly maintenance) and environmental terms (since typical engineering can imply heavy impacts on local ecosystems: flood defences can exacerbate land subsidence, increase flood risk in downstream areas, affect fauna behaviours, mutate the natural adaptive capacity of shorelines and rivers) (Temmerman et al., 2013; Rizvi, Baig, & Verdone, 2015). NBS can contribute to decreasing risks and the general impact of ruinous events by: i. supporting and improving existing traditional technologies (examples are the reinforcement of existing dykes by the use of natural elements, or forest restoration to better mitigate runoffs and landslides); ii. outlining new perspectives and approaches inspired by ecosystem processes (such as the re-meandering of stream beds for regulating water flows, or the enrichment of sedimentation processes to reduce coastal erosion). NBS seem to be a potentially more cost-effective alternative from different perspectives: i) looking at the current and future large expenditure of European governments for the maintenance of technological-based infrastructures and for preventing further degradation of ecosystems and unsustainable exploitation of natural resources; ii) focusing on the social and economic advantages that NBS can boost, unusual for traditional approaches. Furthermore, providing multiple functions and benefits, NBS offer shorter-term benefits compared to the longer-term ones generally generated by risk prevention activities (European Union, 2015, p. 33). However, NBS need innovative governance, institutional and business models, leveraging both public and private funding opportunities involving broad groups of stakeholders (European Union, 2015, pp. 5, 21, 24).

THE "BUILDING WITH NATURE" INTERREG PROGRAM

Flood-risk is considered one of the most important risks in the North Sea Region in terms of potential human losses and economic damage. The 2016-2020 "Building with Nature" Project (BwN)[253] is part of Interreg Vb North Sea Region Programme (priority 3 "Sustainable North Sea Region") and conveys fifteen partners belonging to governmental agencies and knowledge institutions from seven countries – Belgium, Denmark, Germany, Scotland, Sweden and The Netherlands, plus Norway as observer partner – around thirteen "pilot cases"[254] (Figure 101) that act as "testing sites" of NBS which aims at making coasts and river basins more resilient to climate change: the ambition is to reduce flood risk and coastal erosion while enhancing ecosystem services. Ecoshape Foundation and Delft IHE Institute for Water Education are involved in the program as experts for "business case development" (Ecoshape) and for

[253] The project website: northsearegion.eu/building-with-nature

[254] For information about each pilot: northsearegion.eu/building-with-nature/living-laboratories

investigating upscaling possibilities and policy capacity building (IHE). The author took part in the preliminary activities at IHE Delft Institute between 2016 and 2017.
Even if examples of nature-based interventions are already implemented across Europe, the debate on NBS lacks of empirical sound evidence to confirm the theoretical effectiveness and continuous benefits expected from them, also in terms of cost-benefit efficiency, as well as the appeal and potential for transferability and upscaling of solutions (Kabisch et al., 2016; Narayan et al., 2016; Nesshöver et al., 2017). These aspects need further investigations for ensuring a pervasive predisposition of public and private actors for the implementation of NBS as reliable and "not-too-ambitious" methods of nature-related risk reduction. The aim of this in-progress research is to enquire the success, challenges and benefits deriving from NBS for improving (and sharing) the co-production of robust transnational knowledge about nature-based practices and their effectiveness, providing data and guidelines from the operative performance of ongoing initiatives. Multidisciplinary and transnational grounded evidence are pivotal for optimising the technological and economic effectiveness of these solutions (e.g. monitoring and analyses contribute to improving design and developing business cases) and therefore for justifying future investments (e.g. for incorporating NBS in national investment programmes or strategies).
The pilot cases are seven coastal sites along the North Sea and the Wadden Sea and six "catchment scale" (estuaries, rivers and lakes) sites, shown in Figure 101. The pilots are generally parts of regional scale programs of intervention – even when implemented as localized actions – and are mainly top-down projects led by regional or national institutions. *Coastal sites* are involved by sandy management strategies: coastal protection is achieved by introducing complex nourishments (mixing beach and shoreface ones) while stabilizing dune morphology, reducing therefore coastal erosion and consequently the coastal flood risk in the urbanized and agricultural inner lands. Nourishments are monitored to understand their dynamic behaviour, the influence on sediment deficits and balances, and their overall effectiveness for protection from storms (as in Dutch and Danish pilots no. 5 and 11: Wilmink, Lodder, & Sørensen, 2018). Sand-strategies co-operate with flora-strategies, both under the water (through marine eelgrass transplant, such as in pilot case no.13: Wilmink, 2017b, pp. 9-10, 12), both along the beaches (through vegetation restoration) for reinforcing dune ecosystems, controlling therefore the three-dimensional coast profile (as along Denmark's coasts, pilot cases no.11: Thomsen, Astrup, & Lassen, 2018a, 2018b). *River sites* test projects of ecological restoration and flood risk reduction: the landscape redesign of rivers enlarges the space for water by "re-meandering" river paths and creating "safe-to-flooding" zones, consequently reducing water speed for better managing high water levels and increasing water infiltration, as in the "Room for the River" Dutch Program (pilot case no.4: Quartel, Schielen, & Kater, 2018). In the meantime, the interventions aim at ameliorating the ecological quality of local systems, recreating wetland habitats and ponds, strengthening river vegetation and the migration routes for flora and fauna enhancing local biodiversity.
These sites are the results of "multifunctional interventions" which introduced new functions – mainly recreational ones – or reorganised the pre-existing land uses in the transformed areas. In Kleine Nete river pilot (pilot no.3: Moeskops, 2018) the restoration of the river involved the reorganisation of a camping site and of an amusement park; in the Eddleston case (pilot no.1: Spray, 2017b) the redesign of the river path directly involved the local farmers which became active stakeholders in the strategy.

Figure 101. Interreg “Building with Nature” pilot projects. Elaboration of the author.

The author took part in IHE’s preliminary activities addressing the goals “Upscaling: Practice, Policy and Capacity Building”: to investigate governance barriers and opportunities, and define policy and research gaps for strengthening the evidence-base about NBS and their upscaling, both for practitioners and policymakers. Between September 2016 and October 2017, the author could join two Coordination Meetings and carry on an interview campaign with seven officials (representing the BwN partners) involved in the projects’ design and/or the implementation phases. The investigation was focused mainly on: the decisional processes fostering the adoption of nature-based approaches; enabling factors and challenges faced both in the design and in the implementation phases; the “resilience” of projects; knowledge gaps and upscaling opportunities, coherently with the purposes of this thesis.

PRELIMINARY FINDINGS

The author resumes here the results of her preliminary investigation on BwN pilots coherently with the focus of this thesis, identifying main barriers in NBS implementation, and pointing out policy and research gaps. NBS in BwN Project act as living engineering solutions that contribute to reducing to flood risk while enhancing ecological services and enlarging the uses of the places, rather differently from the approach of traditional engineering for flood defence. For a fruitful implementation of nature-based solutions, synergetic multiple systems at different scales must be involved: such condition requires openness to new approaches (as well as to mutual compromises) and the will in building a strong network of social, economic and institutional actors (as well as efforts to keep them involved in the long run) through cross-sectoral forms of cooperation.

PAST DISASTERS AS WIDOWS OF OPPORTUNITY FOR LONG-TERM INNOVATION

The roots of the pilot projects go back to research and experiences carried on in each country since the 1970s-1980s, even if the current enactments dates back to mid-2000s mainly. In almost all cases, previous ruinous floods had a triggering pivotal role in opening windows of opportunity for pushing towards new large-scale strategies against climate-related hazards. The BwN pilots confirm therefore the theoretical framework (§Ch.2.1) investigated in this thesis.
All the North Sea Region lived a catastrophic flood between January and February 1953, that represented a first turning point in research and engagement for reducing flood risk by implementing infrastructural large-scale intervention and planning long-term strategies; nevertheless that event, in several cases only *other* succeeding floods actually triggered innovative responses. In Belgium, after 1953 disaster a Polder Act was emanated but the large "Sigma Plan" for flood risk reduction was issued only after a second violent storm in 1976, including the Kleine Nete river (pilot no.3). In the Netherlands the 1953 disaster gave birth to the Dutch program "Delta Works"; five decades later, the "wake-up calls" set in motion by the floods in 1993 and 1995 ("when river levels almost caused dyke failures) led to the new programme "Room for the River" (pilot no.4) approved by Dutch parliament in 2006 (van Herk et al., 2013). In the United Kingdom the 1953 event pushed the introduction of standards for coastal protection and storm tide warning system for the east coast (including the 1970s Thames Barrier in London) (Johnson et al., 2005); after 2007 floods in England and Wales, a greater focus was dedicated to innovating flood reduction strategies in all the United Kingdom, leading to the ground-breaking Flood Risk Management (Scotland) Act in 2009 and projects as the Eddleston river's (pilot no. 1) (Spray, 2017b, p. 7). In Denmark, a severe storm in 1981 showed the inefficiency of the structural coastal protection in place along the Danish North Sea coast (pilot no.11) (Thomsen et al., 2018a, p. 6). In Germany, the Lower Saxony pilot (pilot no. 9) has its roots in the master plans for coastal defences issued since the 1970s in response to massive storms that hit the area in the early 1960s and 1970s. The storm that involved Germany and Denmark in 1981 pushed for revising coastal protections strategies, even if the plans for Frisian Islands date back to 2010 (Wilmink, 2017a, p. 17).

HOW TO FOSTER INNOVATION?

NBS involved in BwN Project often integrate existing methods of flood risk reduction based on traditional engineering solutions, as outlined above. An example is the creation of sandy foreshores for reinforcing and protecting coastal levees (e.g. East Frisian Islands, pilot no.9: Wilmink, 2017a, p. 17; Houtribdike, pilot no.6: Wilmink, 2018): the use of only NBS requires large-scale integrated solutions, as for instance on large portions of a river basin in case of river flood risk (as in the Eddleston river case, pilot no.1: Spray, 2017b, p. 7). Hence, these interventions represent a "mixed method" for flood defence where hard and soft infrastructures jointly form a flood protection system adding environmental benefits. Indeed,

BwN pilots rely on each country's long traditions in "soft interventions" born from pre-existing preservation strategies or research programs. This common characteristic highlight the crucial importance of a forerunning fertile ground for promoting innovation: in the last two decades innovative nature-based engineering pilots could find space in these large-scale and long-term strategies, also because the continuity in policies secured opportunity and funding for "failure-safe" experimentation. These elements conversely confirm what stated in §Ch.3: the lack of long-term strategies for risk reduction represents a weakness (as for the "Italian system") for a more effective risk prevention on the one hand, and for pushing innovation of the other hand.
Long-term robust partnerships between policy levels and academic research are reported as well: in The Netherlands, science-policy partnerships are embedded in the country governance since decades, as exemplified by the institutions of research programs and specialised advisory boards for policy advice; the Scottish case here investigated is part of a long-term research program involving institutions, local communities and the University of Dundee.
From the point of view of the technological approach used, the countries involved in BwN Project share a robust accumulated knowledge, skills and investments in this field: beach nourishments have a long tradition of application in coastal protection in Europe, especially in Northern Europe (Hanson et al., 2002; Wilmink et al., 2018). The Netherlands sustained research and experiments dedicated to coastal defence since the 1970s, studies that led to the Dynamic Preservation Policies for the coasts in the 1990s, foundation of the current Dutch "tailor-made" practises. Moreover, the emerging limitations of traditional engineering techniques and infrastructures – in terms of both adverse environmental impacts, and of scarce ability to deal with dynamic changing conditions – pushed towards the experimentation of new and more sustainable solutions (Hamm et al., 2002; Spray, 2017a; Thomsen et al., 2018a): "since 1991 soft interventions are preferred over hard structures. Soft (sandy) interventions better match to the natural behaviour and layout of the coast" (Wilmink, 2017a, p. 10). Besides, ongoing long-term preservation policies and normative restrictions, especially in areas of nature conservation, have strongly pushed the shift towards more environmentally sensitive engineering solutions: for instance these aspects have firmly influenced the Belgian approach and design practices.
Currently, thanks to advanced research, collective appraisal and accumulated positive results showed by this kind of approach in the field (well beyond the BwN Project), there is an interesting advance in recognising nature-based interventions as "structural methods" for risk reduction and for adapting to climate change and in some countries these options are slowly becoming a sort of "new standard" – as in The Netherlands or Denmark – where it is not correct to speak about "pilots projects" anymore.

PILOT CASES PUT TO THE TEST

These pilots are widely observed and monitored, producing a potential virtuous system for "innovating the innovation". Interviewees generally refer added local benefits in day-to-day ordinary conditions, above all about all the ecological restorations of habitats and about the extra recreational uses of the landscapes transformed by BwN pilots: the beach nourishments increased the use of the beaches by the inhabitants, enlarging users' and stakeholders' networks.
Examining the core goals of these pilots – reducing flood risks and adapting to a changing climate – the results are still partial. The pilot cases generally seem to well respond to stresses, confirming both partners' (especially Ecoshape's) experience with nature-based interventions,

and the trends traced in literature. Not all pilot sites have experienced acute shocks yet: therefore, there is no data about their response to high impact events. Clearly the pilots have a positive effect on the reduction of risk, by reducing directly or indirectly hazards or exposure: the reshaping of river beds have augmented water capacity and reduced water speed, and the reinforcement of dune systems reduce the flood risk for inner lands. Nature-based measures appear clearly successful if evaluated through a "multiple-benefits matrix of evaluation": this topic has been debated between partners. NBS seem to need a "novel" ad hoc methodology to be analysed and evaluated. Costs, benefits and added values need to be assessed in mutual relation. Concentrating the analysis only on the flood management/climate change adaptation goal, the pilots show positive results but no self-evidence of their effective performances. How to effectively check the mutual relations between costs and benefits, between added non-monetary values (aesthetic or environmental benefits, or recreational values) and reduced risks is therefore the new testing ground to explore according to many interviewees. Moreover, NBS are *per se* oriented to long-term results, and the short-medium temporal term can be a challenging phase in technological terms, in the overall governance of the process, and for developing assessments. In terms of economic cost-benefits evaluation, NBS seem cheaper in terms of investment costs compared to traditional engineering, but maintenance costs are not clear, also because shared among different actors. The necessity of a profound comprehension of local systems, clearly fundamental for designing NBS, affect also the evaluation of their performances and costs: for instance, the same typology of intervention applied by two partners reveals huge difference of performance and costs.

One clear difference relies on the easier-adjustability of NBS to future adaptations with limited fuss, which is not often the case with traditional engineering approaches; they do seem to provide wider and longer indirect or consequential benefits which will contribute to local resilience, but there is no "typical method" to quantify the long-term benefit of nature-based interventions on the local adaptation to climate change.

While being still partially experimental, unexpected externalities due to NBS have become clearer after the implementation of the pilot projects and will need further studies according to partners. Environmental undesirable impacts are recorded, on local ecosystems directly involved by the pilots, or in the surroundings, such as large aeolian transportation of sands nearby beach nourishments, or the conflicts about landscape transformations that are not always welcomed by local communities, affectioned to their traditional domestic geography. The "ecological footprint" of the project is investigated as well, questioning for instance the impact of sand mining. As in any large spatial change, NBS add also vulnerabilities to the local system, and consequently some additional environmental impacts, moving forward the investigation about the "sustainability" of NBS themselves: how to make NBS energy-efficient or neutral? How to achieve "sustainable" sediments additions?

MOVING BEYOND EXTRA-ORDINARY PROJECTS

From some points of view, these pilots are not "so innovative". As explained, in some countries NBS are already out of the "experimentation phase" and recognised as "ordinary" ways of intervention thanks to accumulated experience. Moreover, due to the advanced phase of implementation of some projects, calling BwN cases as "pilot trials" seem inappropriate (BwN Policy Learning Group, 2018).

Nevertheless this disclaimer, NBS are not a common "flood risk reduction approach" yet. The accumulated knowledge on climate-related risks and the related programs for risk reduction already in place in the partner countries, together with the growing scientific and institutional awareness on the potential role of green infrastructures, have been facilitating elements in the decisional processes that led to the choice of NBS in the pilots.
Moreover, NBS are not capable to completely substitute traditional interventions; indeed, main challenges reported by interviewees regard how to gain robust and shared consensus around these non-conventional solutions – because "when it comes to safety, people want guarantees" (BwN Policy Learning Group, 2018, p. 2) – and securing financial resources in the long run for expanding or replicate the pilots. Furthermore, the upscale of these experimental interventions must face ordinary administration and regulatory constraints which represent a strong obstacle for "going beyond the pilots": on the one hand, partners stress the institutional and administrative barriers to move from pilots towards "ordinary NBS" because the latter do not or cannot "fit" within existing rights or with administrative praxis. On the other hand, floods are not "blocked" but slowed down and desynchronized through nature-based interventions, and therefore interventions must involve (directly or indirectly) large territorial scales to be effective, and therefore managerial and political commitment in interinstitutional governance is needed for implementing this kind of projects. Organizations are comfortable with applying traditional measures, while NBS are not traditional, and are based on a holistic approach involving multiple stakeholders, clashing therefore with monofunctional organizations (BwN Policy Learning Group, 2018). This statement affects consequently also the framing of upscaling activities, highlighting the need for active partnerships between policy levels and research activities to break implementation barriers (§Ch.6.4).

KNOWLEDGE NEEDS AND KNOWLEDGE GAPS: CONCLUDING REMARKS

Even if the success of NBS is generally recognised and the interest in nature-based approaches is evidently growing worldwide, some important knowledge need and knowledge gaps need future and larger attention.
NBS represent non-ordinary forms flood risk reduction, therefore they shouldn't be assessed as if they were traditional flood defences. Consequently, more data (e.g. integrated measurements during and after extreme events) and applied research are needed to define a suitable "multifactorial" approach for evaluating their performances, costs, life-cycles and multiple benefits while reducing flood risk. Moreover, NBS need to be planned, designed, implemented and evaluated embracing a system perspective because they must be grounded on a very exhaustive knowledge of local ecological systems and dynamics, since these interventions take advantage of natural dynamics and forces present in the ecosystems. Site-specific characteristics vary widely across habitat types and affect NBS more than standardized and less dynamic solutions. Indeed, the design for NBS sometimes moves from very indicative preliminary projects, to be detailed later during the implementation phases, because systems' behaviours cannot be perfectly modelled in advance. Nevertheless the evident high site-specificity of this approach, more indicators and parameters to describe NBS performances are needed for supporting a larger diffusion. How to build suitable methods for evaluating NBS for flood risk

reduction – and test them in multiple contexts – is a key goal of the near future: gaining grounded evidence and data is recognized as a crucial key absence in the realm of NBS (European Union, 2015).
This consideration leads to another emerging aspect of investigation, associated to the shift from "traditional engineering" approaches: a "resilience thinking" for flood risk reduction is more and more common in many domains, and especially in North West Europe. NBS can be considered examples of the shift from the "mitigation and recovery" paradigm (predict and control) to "adaptive and transformative" paths to cope with nature-related risks (Davoudi et al., 2012; Wamsler & Pauleit, 2016): even if not yet tested during extreme events, interviewees believe that NBS in BwN Project are actually "resilient", interpreting resilience as capability of systems' behaviours and as transformative response to uncertain events through composite paths. From the interviews, the resilience of NBS seems to lay mainly in their robustness[255], flexibility[256], resourcefulness[257] and capability of responding to sudden events[258]. How to confirm and "assess" these resilient attributes would be an interesting research development.

Coherently with what affirmed in this thesis, the history of BwN pilots confirms the triggering role of disasters in fostering technical and policy innovation in the field of risk reduction on the one hand, and the boosting role of ad-hoc research programs and science-policy collaborations for breaking governance barriers on the other hand.
NBS in BwN pilots reinforce complementarily the traditional infrastructures adding new environmental benefits: yet, NBS are not able to entirely substitute traditional solutions. They could be described as "complex hybrid solutions" for flood risk reduction. Two particularly interesting and fundamental characteristics of these pilots derive from such complexity: the essential *strategic nature* and *supra-local spatial scale* of NBS. The pilots are all embedded in large-scale, long-term strategies for risk reduction, where unconventional solutions like these NBS could find a safe space for experimentation: such long-term horizons seem missing in the Italian panorama of interventions for nature-related risk reduction. ItaliaSicura funding criteria sustain the experimentation of "green projects" – even if timidly evoked – proposing additional funds (+20%) to projects for flood risk reduction able to ameliorate the ecological status of rivers and preserve local ecosystems and biodiversity (DPCM. 28 maggio, 2015).
Clearly, the "approach-shift" that is the basis of NBS – from working against nature to working with it – represent an interesting frontier for disaster risk reduction.

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[255] Robust systems include strong, well-managed assets, capable to withstand the impacts of disruptive events keeping the essential functions without significant damages. Robust design and related skills are ready to anticipates potential failures in systems, ensuring that failure is expectable and controlled (Chelleri & Olazabal, 2012; The Rockefeller Foundation & ARUP, 2014a, 2014b).

[256] Flexibility implies that systems can perform essential tasks under a wide range of conditions, evolve and adapt in response to changing circumstances and safe-to-fail. This may favour modular approaches to infrastructure or ecosystem management, always ensuring their interconnections (Allan & Bryant, 2011; Tyler & Moench, 2012; The Rockefeller Foundation & ARUP, 2014a, 2014b).

[257] Resourcefulness implies the efficient mobilisation of human, financial and physical resources under stress, finding also alternative ways to achieve goals or meet needs (The Rockefeller Foundation & ARUP, 2014a, 2014b).

[258] Reflective systems accept uncertainties and changes and are able to continuously evolve and modify standards; people and institutions learn from their past experiences, and leverage this learning to improve performances and inform future decision-making (Chelleri & Olazabal, 2012; Tyler & Moench, 2012; The Rockefeller Foundation & ARUP, 2014a, 2014b).

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