

multi-Risk sciEnce for resilientT commUnities underR a changiNgclimate

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1. Technical references

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2. ABSTRACT

This document provides a summary of the main research activities undertaken, ongoing and planned by Task 2.4. The focus of the document is to outline a methodology for the identification of good risk management practices at the urban and metropolitan level. During the development of the project's methodology, the research team identified several theoretical challenges related to the selection of best practices in Disaster Risk Management (DRM). These included: the role of the local context in providing resources and conditions for the design or adoption of best practices; the impact of that same context on the transferability of best practices; the need to test practices to legitimately define them as "best practices". An interdisciplinary reflection on these theoretical issues led the team to reconsider the initially planned project output. Instead of producing a static repository of best practices, the team decided to develop an innovative methodology for recognizing them. The first one analyses different institutional protocols in DRM and extracts the different indicators considered useful for identifying good practices. The second uses a territorial reference context to reconstruct, through interviews with a selected sample of actors, the practices adopted following a specific risk, floods, in a specific context with a high level of exposition, the city of Genoa. Results confirm that factors and indicators described in line 1 and practices detected and analyzed in line 2 are coherent. The next phase of this research will focus on applying the methodology to other types of risks and diverse contexts, to further test and validate its effectiveness.

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4. Report of activities at 30.11.2024

4.1. Introduction

The mitigation of disastrous effects induced by calamitous events resulting from natural phenomena requires a good understanding of the causes that produce them and the possession of suitable tools to contain the damage caused. This knowledge and expertise should be the heritage of both technicians, scientists, and experts, and policymakers as well as ordinary citizens, in a manner and extent relevant to their respective social profiles. The significant damages repeatedly observed, especially in terms of loss of human lives, instead testify to an unsatisfactory dissemination of knowledge and uncertainties – often confusion – in the skills expressed by the various actors involved in the governance of environmental disasters.

The concept of Best Practices (BPs) encapsulates the set of knowledge, skills, and functional tools for managing the risks posed by disastrous natural events in their various phases (see pp. 11–12 of the document for a short literature overview). It is grounded in risk awareness and in actions aimed at countering or mitigating potential impacts. Repositories of *best practices* are typically built on successful firsthand experiences.

However, as recent literature shows (Bernstein & van der Ven, 2017; Breshneider et al., 2005; Wu et al., 2023; Rizzoli et al., 2024), the notion of “best” is not neutral. It often implies prescriptive and generalising intentions, rooted in comparative approaches and sometimes detached from the contexts in which practices emerge. Conversely, the term Good Practice (GP), as adopted in this research, emphasises descriptive and situated dimensions: an action carried out in a specific context, with relative effectiveness and a potential—but not automatic—degree of transferability.

The literature also highlights intrinsic limits in selecting BPs through static repositories:

- It is rarely possible to verify comparability across contexts or establish clear causal chains between a practice and its impacts (Breshneider et al., 2005).
- Many catalogues rely on secondary data and generic claims, with limited empirical validation (UNDRR, 2023; Rizzoli et al., 2024).

Against this backdrop, the project moved from the initial goal of creating a repository of good/best practices in DRM to designing an innovative methodology for recognising and assessing them, able to combine descriptive accuracy, contextual sensitivity, and evaluative rigour. Building on the literature and the critical reflections summarised above, the methodology was articulated along two complementary pathways.

The “Line 1” focuses on grounding the identification of practices in a clear theoretical framework.

- It adopts the distinction between *best* and *good* practices, acknowledging that the former tend to universalise while the latter remain anchored to context.
- It draws on evaluation criteria emerging from recent studies (relevance, innovation, effectiveness, sustainability, replicability: Wu et al., 2023), as well as typologies such as *promising*, *demonstrated* and *replicated* practices (Rizzoli et al., 2024).
- The aim is to define, for each domain and context, which criteria qualify an action as a “good” or “best” practice, and to clarify their descriptive vs. prescriptive scope.

The “Line 2” operationalises and tests the criteria through field research:

- Identification of candidate practices via case studies, with attention to their genealogy and evidence of effectiveness.
- Documentation of their objectives, mechanisms, and enabling conditions.
- “Extrapolation” analysis (Rizzoli et al., 2024), i.e., observation of whether and how practices spread across organisations or territories, in order to estimate their transferability and limits.

Together, these pathways form an iterative process that links conceptual reflection with empirical observation, overcoming the static and prescriptive logic of traditional repositories.

In this deliverable, given the complexity and at the same time the uncertainty of the scientific use of the expression “good practice” we adopt a two-pronged approach hereinafter referred to as “line 1” and “line 2”.

The exemplification of possible *good practices* is multiple and documented in technical reports and case study commentaries, among which the most well-known ones include: the SENDAI framework (UNDRR, 2023); the two Baltimore reports from 2013 and 2018 (FEMA, Baltimore Disaster Preparedness and Planning Project. A combined all hazards mitigation and climate adaptation plan, 2013) (FEMA, City of Baltimore Disaster Preparedness and Planning Project. A combined all hazards mitigation and climate adaptation plan., 2018); the Santa Fé framework (Maurizi V. F., 2017), and others more recent, related to climate variations (Stults M., 2017) (Maragno D., Dall’Olmo C.F., Pozzer G., & Musco F., 2021). In these contributions, the approach used to identify good practices can be defined as “direct” because these practices are directly recognized as procedures that would have mitigated the damage effects induced by the observed calamitous event in specific cases.

4.2 Description of completed Activities

4.2.1 Line 1

The research was carried out applying an inductive approach for the definition of Good Practices, based on the identification of cultural, social, political and economic indicators, generally defined considering various disaster situations, that can be easily adapted to different urban contexts. Such an approach allows for the development of a flexible and dynamic methodology for the identification and cataloguing of Good Practices that, even if not tested in catastrophic events, can be considered “promising” as they meet established criteria in DRR practices.

Methodological aspects

To identify useful indicators to determine which are the “Good Practices” for urban and metropolitan multi-risk management, an inductive methodology based on bibliographical references is proposed, that followed two fundamental steps.

In Step 1, starting from the definition of ‘Good Practice’ [1-2], a set of national and international programs and frameworks addressing the issue of multi-risk management at the urban and metropolitan scale, were analysed. For each program, **dimension descriptors** were extracted, corresponding to the objectives, targets, and priorities outlined in the analysed documents. For each dimension descriptor, the WG developed one or more **promising indicators**, both qualitative and quantitative, aimed at assessing the extent to which the objectives, targets, and priorities of each programme are achieved, indicating the effectiveness of the programme itself. Following the principle of redundancy of information given by each programme, the extrapolation of promising indicators was focused on five frameworks [3-7].

In Step 2, the promising indicators were examined through a co-occurrence analysis, which resulted in the identification of three different hierarchical clusters for indicator’s classification. At this stage, through a comparison between experts composing the WG, the promising indicators were merged, rewritten and standardised in the form of **variables**, expressed as questions that must guide the end user to understand whether the specific information is contained in practice. Variables were classified into clusters resulted from the co-occurrence analysis and grouped into 9 **criteria**, characterized by homogeneous topics aiming at including all features of risk assessment and management. The variables considered were also classified according to the stages of the Sendai Framework.

Steps 1 and 2 complete the first part of the methodology, resulting in a **set of indicators** useful to identify practices for multi-risk management in urban and metropolitan settlements, that is one of the expected outcomes.

Results

A total of five international programs addressing the broad spectrum of DRR were analysed, extrapolating the relevant dimension descriptors from their targets and priorities. One or more promising indicators were developed for each dimension descriptor. At this stage, the indicators are considered promising, with the understanding that only after the process of clustering and standardization consistent with the objectives of the RETURN project (Step 2), they are confirmed or not as best practice indicators for multi-risk management in urban and metropolitan environments.

From the co-occurrence analysis performed on the 236 promising indicators, three different hierarchical clusters were derived to classify the indicators:

- **Cluster 1 (measurability):** Identifies the degree of measurability of the promising indicators, dividing them into qualitative and quantitative indicators (type, number, percentage, etc.).
- **Cluster 2 (dimension):** Identifies the dimension to which the promising indicators refer, broken down into the following variables: social, economic, cultural, political, infrastructure, construction, environmental, and ecological. More than one dimension may be indicated.
- **Cluster 3 (Sendai Framework phases):** Identifies the risk management phase to which the indicator refers, concerning those identified in the Sendai document. This classification aligns with that already adopted in the ROADMAP project [8], which is used as a reference in this study, distinguishing the stages of Understanding Disaster Risk; Strengthening Disaster Risk Governance; Investing in Disaster Risk Reduction for Resilience; and Improving Disaster Preparedness for Effective Response and Better Rebuilding in Recovery, Rehabilitation and Reconstruction. More than one phase may be indicated.

Overall, **132 indicators** were organized into **9 criteria**:

- **Criterion 1 - Risk dimensions:** Identify the dimensions and types of risk considered by a practice, considering that the RETURN Good Practice Catalogue will apply to the management of multi-risk scenarios in urban and metropolitan settlements.
- **Criterion 2 - Ecosystem services, structures, and green and blue infrastructures:** Assess whether the Decision Stakeholders, who apply the practices, have an in-depth knowledge of the city's infrastructure, including protection infrastructure against prevailing hazards, and whether its state of maintenance and operation is regularly monitored and maintained.
- **Criterion 3 - Practices validation and update:** Understand whether Decision Stakeholders adopt tools to verify the effectiveness of practices before the occurrence of a catastrophic event and whether they periodically update maps and standards describing the most severe risk scenarios.
- **Criterion 4 - System of Stakeholders / Policymakers:** Comprehend which and how many Stakeholders and policymakers are involved in the design and implementation of the practices, and whether there are structured relationships between the different actors.
- **Criterion 5 - Empowerment of vulnerable groups:** Address whether Stakeholders implementing practices are aware of the presence of vulnerable groups, and whether and how these groups are involved in the design of risk management policies.
- **Criterion 6 - Public communication:** Determine risk communication strategies practised by Stakeholders, and whether strategies have been developed to evaluate their effectiveness.
- **Criterion 7 - Training:** Understand what training actions are implemented by Stakeholders, and whether strategies have been developed to assess their effectiveness.
- **Criterion 8 - Economic measures stored/invested for public and private resilience:** Evaluate what economic resources have been dedicated in cities for risk management, whether these resources are considered sufficient, and how much they weigh against the overall public budget.
- **Criterion 9 - Community engagement and social capital:** Examine whether and to what extent the community is involved in the design and implementation of applied risk management practices.

Criticalities

A potential limitation could be considered the number of international programs analysed to extract Good Practice indicators. However, the five frameworks considered cover different application scales and origins,

including technical, political and research dimensions. The detailed analysis of these programs early on revealed a considerable redundancy among the promising indicators, verifying the comprehensiveness of the collected information.

By design, the indicators developed are applicable to the specific setting of multi-risk management in high income urban and metropolitan settlements. Thus, other indicators may be needed in other settings.

Experts involved as internal Stakeholders belong to the Italian context. This feature could represent a criticality. However, the Italian territory includes many different risk settings (volcanic, seismic, brady seismic, land-slides, floodings, heat-waves, etc.) providing thus expertise in a variety of multi-risk scenarios. Moreover, many Stakeholders involved in the working group have international experiences in DRR management.

The diversity of internal Stakeholders constitutes an element of strength, however it has also led to the emergence of varied perspectives, including semantic differences, based on which different scholars, in relation to their expertise, evaluate and interpret indicators differently. On the positive side, this fosters opportunities such as the shared understanding of fundamental semantic codes related to risk management issues and the mutual exchange of knowledge and skills.

So far we have a usable tool for evaluating Practices for multi-risk management in urban and metropolitan settlements in high-income countries was produced, as well as a methodology that could allow to develop similar tools for other contexts.

Connection with other Tasks, WP, Spoke

The elaboration of the 132 indicators and related variables, and their standardisation into 9 criteria, was carried out by means of a comparison between internal Knowledge Experts involved in the RETURN project, which, in addition to the scholars of Task 5.2.4, TS1, also involved the scholars of Spoke 3 - VS3 'Earthquakes and Volcanoes'.

See Annex 1: set of 132 GPs's indicators

4.2.2 Line 2

Premises, objectives and outputs of the research

The objective of this line of research is to understand how risk management practices arise in a specific local context and which processes contribute to define them as 'good'. Furthermore, to verify whether the action patterns that these practices embody are consistent with those isolated through the indicator procedure, mentioned in the previous paragraph.

Inspiring this second line are the two following arguments found in the literature:

- The first, is that good practices are such because they are designed and implemented in at least one context, and have a potential for transferability (Nelken, 2010; Bernstein and van der Van, 2017; Rizzoli et al.2024).
- The second is that good practices are also such when they introduce incremental improvements over the previous performance of a specific actor/territory, and when such improvements have already been adopted by other actors (Wu, Liu and Bretschneider, 2023).

Good practices are, therefore, not procedures, but concrete actions, implemented in contexts with specific characteristics and endowed with as many specific resources, which have proven to be effective in at least one phase of the risk management cycle and have a potential of replicability.

For these reasons, and because of the need to produce results in a short time horizon, the research design focused on

- A specific hazard: floods following heavy rain;
- A local context particularly exposed to the occurrence of this hazard: the city of Genoa;
- An actor that has a crucial responsibility in several phases of risk management and has a broker role (Burt, 2006) within the local civil protection network: the Municipality;
- A case study where it was possible to interview privileged witnesses who had played a relevant role during the occurrence of the hazard and subsequent actions.

The research design therefore observed the way in which the Municipality of Genoa, which has been subjected to severe flooding 11 times (with victims and significant damage to infrastructures and the surrounding environment) since 1970, with two dramatic episodes in 2011 and 2014, has 'learnt' from the events, putting in place actions on a cognitive, organisational and infrastructural level.

The main output of this line of research is to build a replicable research design on other hazards and in other contexts, in order to explore a '*palce-based*' way of identifying good practices. The expected output is not limited to the content of the good practices in the peculiar Genoese context, but to the observation method and the theoretical grid constructed for the case study analysis.

The decision was therefore to focus the analysis on Genoa, which, of all the cases, was the one where the events were most recurrent, dramatic in terms of victims and damage, and where the socio-economic and institutional context appeared most complex, in terms of the actors involved in the learning processes and the actions carried out.

Literature

The study confronted two strands of literature. The first, related to the concept of best practices and its uses. The second, relating to empirical studies carried out on the flooding events in Genoa.

a. Best/Good practices as object of study

Words are important. To date, there is a substantial literature referring to the concept of 'best practice' (BP), while that of 'good' (GP) still has little evidence. In our opinion, this is not just a matter of linguistic finesse. The two concepts indicate two different objects and purposes. The first refers to a comparative approach, and has a prescriptive and generalising purpose. The second, at least in the sense we attribute to it in this research, describes an action carried out in a specific context, refers to a relative dimension of effectiveness, and has a descriptive purpose, although good practices are also such because they contain a more or less reduced 'charge' of transferability.

As Bernstein and van der Ven (2017) argue, the concept of best practice emerged in the 1980s within the New Public Management (NPM) paradigm. In essence, the concept expresses the transfer of organisational models and values from the private company to the public sector. During the 1990s, the concept of BP changes in meaning, becoming associated with a transfer of policy from public to public: bodies such as OECD/IMF identify a set of actions that are deemed effective and are presented to states as 'the things to do'.

It is only since 2000 that the concept spread from the policy arena to the scientific arena, as evidenced by its recurrence in the titles and abstracts of scientific articles. According to the two authors, the reason for this 'boom' is the spread of international standards in areas such as industrial production and trade, which lay the foundations for a demand for the harmonisation of regulatory schemes and behaviour at a transnational level; also the increasing normativity of international bodies in shaping the economic policies of states,

through guidelines and acts that, while not imposing standards and/or sanctions, define the prevailing evaluation principles.

According to this perspective, BPs are therefore instruments of 'governmental' governance, i.e. ways through which a certain organisation, endowed with authority/authority, establishes guidelines on specific behavioural patterns of actors with responsibilities. BPs, therefore, prescribe, and not only describe, what these organisations consider to be the best strategies to solve certain problems.

Breshneider, Marc-Aurele and Wu (2005) dwell on what conditions are necessary and sufficient to correctly identify and evaluate BPs. These would result from a comparison of alternative practices within the same context. Moreover, they should be the main cause of the benefit that is accorded to their implementation. However, the authors point out that both of these conditions are extremely difficult to verify in a concrete empirical context. Firstly, cognitive biases would intervene regarding who evaluates the effectiveness of the practice. Secondly, comparability would have to take place within only one context, because it is extremely rare to find two with complete comparability characteristics. The authors, while not renouncing to propose an identification method based on complex statistical inference techniques aimed at establishing causal links without equifinality between the practice (understood as independent variable) and the effect (dependent variable), nevertheless consider that on complex domains, such as DRM, the concept of BP shows a certain weakness. It is indeed difficult, if not impossible, to find practices that are generalisable or at least transferable tout court, and on which the chains of causal impact are clear.

Wu, Liu and Bertschneider (2023) also dwell on the criteria for evaluating BPs. After conducting an in-depth literature review, the authors identify five:

- **Relevance:** the practice impacts a large segment of the population and addresses a problem of high severity and prevalence.
- **Innovation:** the practice introduces new approaches or tools to solve unresolved problems. Innovation does not mean producing something unprecedented but something new in relation to the local context.
- **Effectiveness:** the practice achieves its predefined goals.
- **Sustainability:** the practice maintains its benefits over time. This means that it works even at a relevant temporal distance from adoption, and is economically, socially and environmentally sustainable.
- **Replicability:** the practice can also be transferred to similar contexts, for example, in terms of complexity, resources, or exposure and vulnerability to a certain type of risk.

Empirical research conducted by the authors led them to consider innovation and effectiveness as the most recognized criteria. Rizzoli et al (2024), on the other hand, argue that it is effectiveness and replicability that are diriment in defining a BP. In support of their thesis, they cite the European website of Integration, whereby a practice can be recognized as good if it is accompanied by a clear description of the application context, if it has limited and well delineated objectives, if it does not merely define a procedure but indicates specific patterns of action, if it satisfies widespread needs expressed by stakeholders and target groups of the population, and finally if it is transferable. Referring to Serrat academic work (2008), they propose the identification of three types of BP:

- **Promising:** i.e., practices that although they have not been formally evaluated, have been shown to be effective;
- **Demonstrated:** i.e., whose effectiveness is measurable, even if only in a single context, but is inferred to be transferable to others;
- **Replicated:** a practice "demonstrated" but beyond that found to be widespread in other contexts.

Based on these findings, the authors define a BP (moreover, alternating this concept with good): as “*anything that has been tried and shown to work in some way - whether fully or in part but with at least some evidence of effectiveness - and that may have implications for practice at any level elsewhere*”.

This is a very similar definition to the one proposed in this DV, although there is no reflection in the paper on the implications in the use of best or good practice. The contribution by Rizzoli et al. (2024) is even more relevant to the purposes of this paper because it applies this definition to the topic of DRM. In particular, the authors note that BP/GP are often described as generic claims and identified through secondary data analyses, and only rarely, e.g., UNDRR (2023), are they accompanied by empirical analyses that situate the BP and describe it in its genealogy. Their proposal is a methodology for identifying, documenting and “extrapolating” (i.e., defining the conditions of transfer to other contexts) BPs. Identification should be done through reference to a theoretical framework that establishes, in the specific context where BPs/GPs are detected, what are the criteria for defining a practice as “good.” Documentation requires, on the one hand, the framing of one or more of the criteria defined in the first step as fundamental to defining a BP, and on the analysis of case studies. The third step, extrapolation, involves considering multiple case studies and observing whether and how a certain practice has spread across multiple entities.

This paper does not expose the Genoa case study following this outline. However, the contents set out in the results section may be useful in compiling a potential “phase II” that tries to find good practices in the specific case of flooding.

b. Empirical studies on Genoa Floods

The review of the empirical studies on Genoa was carried out by entering keywords ‘floods’; ‘landslides’; ‘Genoa’; ‘resilience’; ‘disaster risk management/reduction’ on the main academic search engines (WoS and Scopus). It was immediately apparent that most of the contributions, although often in English and published in international journals, came from authors affiliated with the University of Genoa or research organisations with roots in Liguria (e.g. CIMA). A second bibliographic search was therefore carried out using the IRIS-Unige search engine.

The searches were conducted in very different disciplinary fields: from geology to geography, from psychology to engineering. In particular, three clusters emerged:

- Literature analysing the causes of individual flooding episodes, through an analysis of the socio-ecological context of the city.
- Literature that focuses on the relationship between citizens and institutions, and cultural and communicative processes.
- Literature analysing technological prototypes and organisational experiments useful for anticipating future events and strengthening the preparedness of the local context.¹

In relation to the first strand, Genoa is a city particularly exposed to risk or flooding due to both anthropic and natural factors. Like other cities, Genoa grew enormously during the second half of the 20th century. If, in fact, before the Second World War there were about 100,000 buildings, in the 2011 building census there were three times as many. Given the limited space available, the city developed vertically. However, the growing demand for housing and infrastructure, or at least its prediction (the city's PRG of 1980 predicted that the city would have one million inhabitants in 2000), has not spared the areas at high risk of flooding, as

¹ For the sake of brevity of the report, but also for the sake of content in relation to other tasks of the Return Project, a summary of this literature will not be given.

well as the banks and, in some cases, the bed and mouth of the rivers that flow through it. Particularly significant and illustrative is the history of urbanisation near the Bisagno stream and its tributaries, such as the Rio Fereggiano. In the 1930s, the Bisagno was partly covered over to make room for road infrastructure and housing, and this trend continued until the dramatic flood of 1970, which was largely determined by the bottlenecks produced by the drainage. That episode revealed that the calculations on the maximum flow of the torrent and tributaries were completely wrong.

Genoa is also exposed for reasons related to the natural environment. A first element is the orography of the territory, which is characterised by the presence of dozens of watercourses, some of which have a significant flow rate, with slopes that in some parts of the city exceed 50%. A second element concerns the city's position, which is barycentric with respect to an atmospheric depression, called 'Genoa Low' by technicians, whose characteristic is the convergence of hot winds from the southern Mediterranean and cold winds from the Alps. The 'Genoa Low' is more recurrent in the autumn months and facilitates the arrival of heavy rain. Climate change is said to have made the clash between warm and cold currents more extreme than in the past. The consequence is that, while the number of rainy days is reduced, the rainfall rate, i.e. the ratio of rainfall quantity to fall time, increases. This was evident during the 1992 and 2011 floods, where the same amount of rain fell as in the 1970 flood, but in half the time (Faccini et al.2015).

In relation to the second strand, studies have mainly focused on theoretical models on risk perception (Bracco et al.2015) and institutional trust/confidence (Mutti, 2012), with reference to the post-flood of 2011 and 2014:

- In relation to risk perceptions, of note are those developed by Janmaimool and Watanabe (2014), according to which the perception of environmental risk is influenced both by factors related to the nature of the risk, such as the perceived probability of the event and the severity of the consequences, and by emotional and cognitive factors, such as the perceived ability to control and concern for oneself and one's loved ones; the homeostatic theory of risk by Raaijmakers et al. (2008), on the other hand, states that risk perception is influenced not only by the immediacy of danger, but also by pre-existing beliefs and attitudes. Awareness, concern and preparedness influence each other: preparedness reduces concern and, consequently, awareness. Finally, the model proposed by Wachinger et al. (2013), introduces variables such as prior experience and trust in institutions, explaining why awareness and concern are not always sufficient to foster adequate risk management. People may accept risk for perceived benefits or delegate responsibility institutions.
- In relation to institutional trust, Bracco et al. (2015) referred to these models to analyse the communicative processes activated after the 2014 flood, and found how the media, both local and national, played a negative role in building trust relationships between the local administration and citizens, fostering accusatory social representations towards the municipality, de-responsibilising towards citizens' duties, and simplifying the complexity and difficulty of DRR. Bracco et al. (2015), also reconstruct a typology articulating four macro-attitudes in trust relations between institutions and citizens, 'mixing' two poles, 'scepticism' and 'trustworthiness'. When both are high, there is critical trust; when only the former is high, there is a rejection of the institutional message; if only the latter is other, there is uncritical trust; finally, if both are low, there is distrust, i.e. an attitude of thinking that the administration's behaviour in the DRR will be negative in any case.

Methodology

In this section we illustrate:

- The method we used to identify the case study.

- The profiling of the interviewees.
- The method by which we constructed the interview grid.

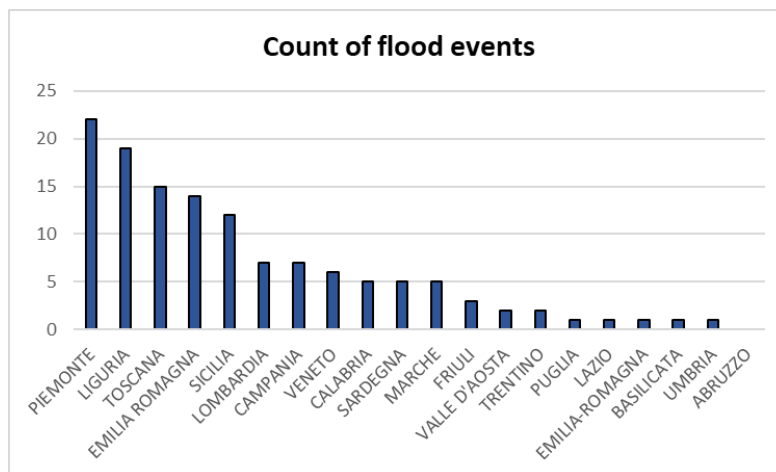
a. Identification of the urban context

Although Genoa is known to be a city exposed to flood risk, the case study was identified through a systematic procedure, which is in itself a first output of the research.

The first step consisted in selecting the unit of analysis, which was limited to Italian metropolitan cities and reference territories. This choice is consistent with the characteristics of the Spoke where the research is located (whose focus is on risk management in the peculiar urban and metropolitan context) and with the need to analyse cases where the learning processes are complex, and see the co-participation of several actors with whom the local administration relates.

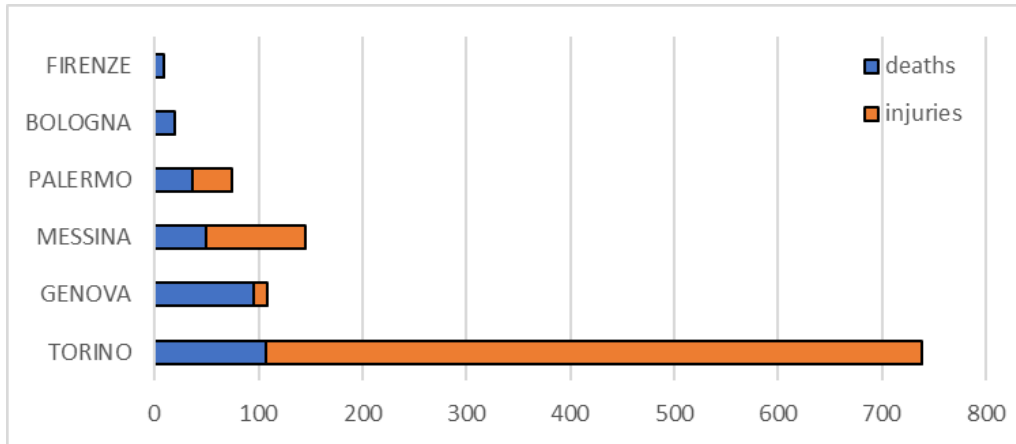
The second step consisted in reconstructing flood events from 1970 to the present day in Italy's metropolitan cities. This analysis was carried out by consulting various databases (fig.1). In the figure the events are collected on a regional basis

Fig. 1 Flood events in Italy from 1970 to present day



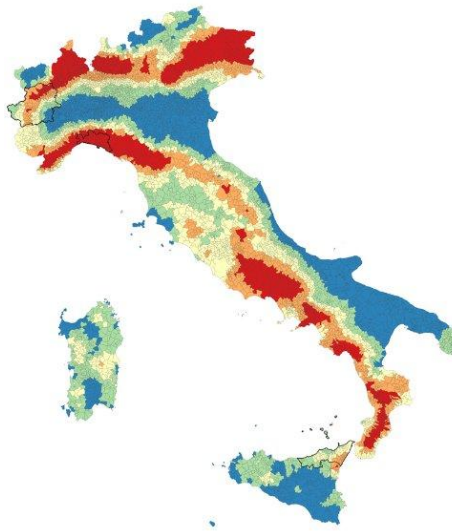
The third step was to identify the 'macro' impacts of these events in terms of deaths, injuries, missing persons and other indicators that signal their traumatic nature (fig.2). In the figure, Turin appears to also include the cities of Asti and Alessandria.

Fig. 2 Deaths and injuries during floods in Italy from 1970 to present day



Furthermore, a final step was the analysis of the cumulative rainfall in the months where the floods occur most, as 'counterfactual evidence' to the reconstruction, carried out in the first step, of the main events that have occurred in Italy since 1970 (fig.3).

Fig. 3 Cumulative rainfall in Italy from 1970 to present day



With regard to Genoa, the choice was motivated by the following factors:

- The highest number of flooding episodes since 1970 (11 episodes) and a number of episodes in recent times, with the possibility of collecting field information from protagonists still in service or alive (floods of 2011 and 2014 in particular);
- Very serious impacts in terms of human casualties and economic damage;
- Pluviometric data confirming Genoa as one of the most exposed territories in Italy to cumulative rainfall.

b. Profiling the interviewees

Between May and October 2024, Unige's research team conducted 15 semi-structured interviews with the following profiles, set out in order of interview completion (tab.1)

Table 1 People interviewed

Name and Surname	Roles	Eco-systems
Marco Doria	Major (2012-2016); Full Professore in History at University of Genoa	Decision / Production
Roberto D'Avolio	President of media Val Bisagno borough (2012 – 2021)	Decision
Maria Gabriella Fontanesi	Responsible for Communication – Genoa Municipality	Decision
Francesco Faccini	Associate Professor in Geography at University of Genoa	Production
Pietro Piana	Researcher in Geography at University of Genoa	Production
Gianni Crivello	Deputy Mayor on charge of Civil Protection (2012-2016)	Decision
Stefano Bernini	Deputy Mayor on charge of Urbanistic (2012-2016)	Decision
Sara Bonati	Associate Professor in Geography at University of Genoa	Production
Massimo Ferrante	President of bassa Val Bisagno borough (2012 – 2021)	Decision
Raffaele Gazzari	Chief of staff of Genoa's Mayor (2002 – 2011)	Decision
Gian Battista Poggi	Director at the infrastructure sector Liguria Region (1998 – 2016)	Decision
Monica Bocchiardo	Director at the civil protection sector Genoa Municipality (2012-2016)	Decision
Antida Gazzola	Associate Professor in Sociology of Environment	Production
Paolo Tizzoni	Director at the infrastructure sector of Genoa Province (1998 – 2007)	Decision

Irene Marras	Director at the civil protection sector (2023-)	Decision
Stefano Pinasco	Director at the infrastructure sector of Genoa Municipality (1998 – 2024)	Production

Respondents were clustered into two “ecosystems,” consistent with the typology developed by the WP6 research team on stakeholder profiling. The decision ecosystem refers to actors with decision-making power and with implementation responsibilities for those decisions. That of knowledge production includes universities, research centers, and public and private facilities that have generated explicit knowledge, namely articles, books, reports, and other outputs on the topic of floods, equipped with a rigorous and scientifically validated method of analysis.

Interviewees were selected based on the criteria of relevance to the research object and availability. Regarding the decision ecosystem, interviews were conducted with policy and management actors with major management responsibilities during the flood events, particularly of 2011 and 2014, and in the learning processes following the traumas. On knowledge production, researchers and authors of papers relevant to the two flood events that were most relevant to learning issues were interviewed. Finally, on knowledge transfer, priority was given to civil protection, environmental, and environmental associations and organizations that came into being as a result of the flood events and activated forms of collective action aimed at river care and hydrogeological risk prevention.

c. The interview grid

All interviews opened with the “handover” (Marradi, 2012), namely by describing the object and objectives of the research to the interviewee and asking him or her to comment with respect to this initial stimulus. The interviewers then used a semi-structured grid as a support for asking questions aimed at filling in the gaps in the first narrative and integrating information useful for reconstructing learning processes.

The interview grid was structured considering, first, the implications of the theoretical model on organizational learning, set out in the previous section. The processes of change that, in the opinion of the interviewees, were activated after the two most recent floods (2011 and 2014) were mapped on three processual dimensions:

- **Cognitive processes:** mapping of the changes that occurred between the flood events on strategies to identify risk types, vulnerability and exposure; Changes in the ability to anticipate events and communicate risk to the citizenry (plans, mapping, etc...); Changes in the training activities of staff with responsibilities in at least one phase of the DRR; Training and education activities aimed at the citizenry.
- **Organizational processes:** mapping of changes in the governance of the local DRR (e.g., of the emergency management committee, administrative structure and organizational chart of the municipal PC sector etc.); Changes in the process of involvement and participation of the public and/or civil society.
- **Implementation processes:** investments and infrastructures planned and/or implemented for DRR in relation to hydrogeological risk; Analysis of any difficulties in the implementation of these interventions and investigation of the reasons for the “blockages”; Effectiveness of the interventions implemented (techno-scientific evaluation, perception of experts and beneficiaries etc...).

The internal track to each of the three dimensions was also constructed by observing emerges from SENDAI, whereby there are six phases of risk management: prevention, mitigation, readiness, response, regeneration and rehabilitation. Particular attention was given to the processes of prevention, mitigation and readiness after the two events, because they were considered most significant for learning. and of the emergency cycle management model emerging from SENDAI. whereby the phases of risk management would be six: prevention, mitigation, readiness, response, regeneration and rehabilitation. *Results*

In this section, the practices recognised as 'good' (tab.1) by the interviewed actors are returned. The order of presentation follows the pattern in the methodology section: practices relating to cognitive, organisational and implementation processes, and related to different phases of "risk management cycle" (fig.4)

Fig.4: Risk Management Cycle (Nuffled Group source)



□

Almost all practices are designed and implemented by the Municipality of Genoa, often in collaboration with other national and regional public entities. Each dimension is described using extracts from the interviews.

Action	Process	Risk Management Cycle
Elaboration of Basin Plans for the main urban rivers	Cognitive	Identification and Mitigation Planning
Institutional mediation to prevent conflicts arising from DRM decisions	Cognitive	Implementation
Additional zoning charges specifically dedicated to reducing hydrogeological risk	Cognitive	Implementation
The activation of census and alert procedures for residents in areas with the highest exposure to flood risk	Cognitive	Identification and Implementation
Design and implementation of a territorial presidium system.	Organizational	Mitigation Planning and Implementation
Evacuation and warning plans were drawn up for each of the school buildings	Organizational	Mitigation Planning

The integration, both administrative and managerial, between the civil defense and municipal police sectors	Organizational	Implementation
Multi-lingual booklet and civil protection Pils	Cognitive/Organizational	Identification and Implementation
Remodeling of the municipal operations center (COC)	Organizational	Implementation
The development of projects regardless of the availability of resources.	Implementative	Identification
Realization of Fereggiano and Bisagno Spillway	Implementative	Implementation

a. Cognitive Processes

In this dimension, we proceed to the description of good practices in flood risk management that are characterised using information and communication processes. In 1970, a very serious flood hit Genoa. The two main rivers (Bisagno and Polcevera) overflow, and along with them, so do their tributaries and other 'rivi', such as the Sturla, Fereggiano and Chiaravagna. Forty-one people die, the city is devastated for weeks by mud and debris. This event starts a debate in the city on what interventions can help mitigate the risk, yet no significant measures are taken. Flooding, many think, is an event that comes along every 100 or 200 years. This would not be the case. The city in 1992 and 1993 is hit by two devastating events, which, although with fewer casualties, show all the limitations and contradictions exposed in section 2.2. of this document. Other events occur in 1997 and 1998, and then come the floods of 2010, 2011 and 2014, all marked by fatalities and extensive damage. According to Raffaele Gazzari, chief of staff to the mayors of Genoa from 2002 to 2011, what explains the slow learning curve, despite the repetition of many episodes, is a primarily cognitive deficit, relating to climate change and the division of roles:

There was not the awareness that there was later. Not just locally, but nationally and perhaps internationally. There was no awareness of how the climate was evolving, of the fact that heavy rains were increasing in frequency, severity, and even "punctuality," that is, of hitting micro-areas. Also, at the national level, there was little clarity about who was supposed to do what. Everything was being delegated to mayors, but without decentralizing resources. Moreover, the focus was mainly on implementing works in an emergency logic, while prevention and organization were underestimated.

A first good practice can be recognized precisely on the level of knowledge and awareness of interventions capable of mitigating flood risk. It is the elaboration of the basin plans (BMP), provided for by Law 183/1989, and implemented in an accomplished and participated form, perhaps for the first time in Italy, precisely in the Genoese context. The owner of this process is not the municipality but the Province of Genoa, which at the time had water risk management responsibilities, now divided between the municipal and regional bodies. Through the BMPs, which are drafted by groups of experts, including hydraulic engineers, agronomists, geologists and urban planners, in collaboration with the technical and political staff of the local authorities, Genoa begins to learn analytically, for each of the main watercourses by which it is crossed, what are the conditions of exposure and vulnerability of the municipal territory, and what interventions are needed to prevent and mitigate the risk. A symbolic figure of Genoa's BMPs is Engineer Paolo Tizzoni, who was manager of the civil engineering department during the early 1990s, vice-president of the Province of Genoa from 1997 to 2007, and later manager of the city planning sector of the municipality. Tizzoni oversaw the drafting of the main BSPs (Polcevera and Bisagno), both in a technical and political capacity.

What makes the Genoa experience particularly remarkable is the participatory process activated during planning:

We did not limit ourselves to scientific-technical studies. We understood that the key to making BSP devices feasible was to build consensus with citizens. So we involved civic committees and social formations formed after flooding episodes and for the care of rivers in setting priorities. We really carried out dozens of assemblies and meetings. Even Maurizio Costanzo thought of doing a broadcast from the Genoa Aquarium to tell about this experience!

Comparisons with citizens have certainly not been easy. In some cases, BDPs included DRM interventions that carried a high cost for a part of the citizenry. This is recalled by Stefano Bernini, whose testimony allows us to observe another good practice, namely institutional mediation to prevent conflicts and associate with orderly and coercive devices, appropriate compensations:

Many of the interventions included in the BSPs involved high costs for both the administration and citizens. For example, the widening of the embankment of some rivers, entailed the suspension of vehicular traffic, which in some cases could mean making it particularly arduous for people to return home, Genoa being a city full of unevenness. In other cases, citizens were living in homes built decades ago, when urban planning standards limiting construction near waterways did not exist. Go tell them you have to tear down their houses! Committees, associations, lawsuits are formed, which slow down the measures.

An example of what Bernini described are the facts about the property located on Giotto Street, a photo of which is shown (1). This building, was one of the main causes of the 2010 flood. It was built in 1953, and (fortunately!) demolished in 2013. *Fig. 4 Building on Giotto Street (Genoa)*



The administrative and legal procedure by which the municipality had to proceed with the abatement was not particularly lengthy because compensation was awarded to the 28 resident families and the various businesses insisting on the property, and because there was mediation by the political plaintiff with the other party. Specifically, the municipality acquired the housing units and bore the abatement costs in full.

A third good practice, which can be considered to mirror that of conflict mediation, is that of providing for additional zoning charges specifically dedicated to reducing hydrogeological risk, in the case of residential or productive investments in neighborhoods with high flood risk. This is what happened with the Genoa High Tech Campus (GHTC) subdivision. A large investment, conducted in the neighborhood of Sestri Ponente, one of the quadrants of the city most affected by flooding episodes and with higher socio-economic vulnerability indicators, was authorized only after the developer carried out interventions on road mobility, sewage systems, and other infrastructure, which located near the Chiaravagna creek, allowed for its more adequate maintenance.

The 2011 flood was a watershed event for Genoa's DRM. All the actors interviewed shared that that episode was the most significant in terms of the impetus for learning. One reason is because the flood had a particularly tragic outcome: the death of two little girls and their mothers inside a condominium hallway near

Via Fereggiano. A second, is that the then mayor of Genoa, Marta Vincenzi, and other municipal officials were prosecuted by the judiciary, and severely convicted for conduct deemed by judges to be gross misconduct, one of the first cases in Italy where a natural event produced criminal consequences for administrators and technicians.

Among the innovative practices introduced in the wake of that event, one of the most notable concerns the activation of census and alert procedures for residents in areas with the highest exposure to flood risk. Specifically, households that are found to be near the most dangerous waterways, and which are sited on the ground floor or in the basement. Resident households are required to leave their homes in case of a severe alert. Lucia Mortara, an employee of the Municipal Civil Defense sector and volunteer, describes this interesting as well as original “micro-practice” of risk prevention:

We conducted, after 2011, an analytical census of households with the highest risk of flooding. To date, we count about 100 households living in homes without access to condominium floors higher than ground level, and 150 with high risk equipped with this exit route instead. We contact via an automated voice message all phone numbers connected to these utilities when we issue a severe weather alert. If no one responds, we proceed with volunteers to post the text of the union order ordering evacuation. We offer the provisionally evacuated families overnight lodging and canteen.

It is no mystery that most of these housing units are inhabited by households with high socio-economic vulnerability. These are in many cases migrant families. One of the problems encountered by the municipality is keeping the records up to date and being able to actually get to those who live in the at-risk dwellings. Also, is that of making oneself understood in some cases, citizens despite living in Genoa, do not know Italian. This, and more generally the need to improve awareness among the city's growing migrant population, led the City of Genoa, in collaboration with the University, to prepare a communication campaign on multi-lingual risk prevention. As recalled by Councillor Gianni Crivello who curated this initiative in 2016, a multi-lingual booklet came out of it, “Safety without borders”:

We decided to print a booklet with the main instructions on how to behave in case of alerts and floods. We were contacted by a group of Ecuadorean families, a community with a strong presence in the western part of the city. With their cultural association, an educational institution, and the support of the University, we started writing a booklet in seven languages, the most common languages among the city's migrant communities, plus Genoese!

b. Organizational Processes

In this section, we indicate some best practices that emerged in the field survey, referring to organizational processes. By this term, we mean initiatives aimed at improving the management and exchange of resources (tangible and intangible) in the inter-organizational municipal and external network. By improvement, we mean the increase in efficiency, effectiveness and/or sustainability of actions. If in cognitive processes, a significant part of the identified action patterns concerns prevention activities, in organizational ones there is a greater presence of preparedness and emergency response activities.

The current director of the civil protection sector of the Municipality of Genoa, Irene Marras, when confronted with the direct question “what DRM practices implemented by the civil protection sector of the Municipality of Genoa would you feel like bringing as examples for other municipalities as well?”, points without delay to the territorial presidium system. Indeed, the municipality of Genoa is very extensive, and has hundreds of waterways within it, dozens of which need to be attended to when there are heavy rains. Added to this, most of the streams have a “runoff” time that is less than 60 minutes. To intervene promptly

and compute the resources needed to deal with the possible flood, the municipality has structured a complex monitoring system, consisting of human actors and sensors, after 2011. Marras explains:

We have equipped ourselves with many remote sensing instruments: webcams, rain gauges and hydrometers, with the aim of monitoring the filling level of waterways. However, this is not enough to “keep track” of the situation. There are the storm drains to monitor, because a clogged one can create more damage than a storm. There is the condition of roads to be checked and the possible presence of landslides. We have therefore divided the municipal area into routes. Each operator has his own route, has defined case histories and standardized responses. For example, if a road is flooded, the operator has a metric, related to how much water covers the tire of a car, or near streams we have marked notches indicating the level of filling. This communication goes directly to the emergency room, which is therefore able to tell if the alert level is the appropriate level, or if monitoring needs to be increased. In that case, routes and operators are increased.

This practice, which we report in this report very briefly, but which consists of a very complex procedure, has been shared with the National Civil Defense Department, which has included it in its guidelines. This is an “extrapolated” best practice, in the sense proposed by Rizzoli et al. (2024). However, the national regulator's guidance is limited to the need to structure a timely monitoring system. How this can be adopted by municipalities remains within their organizational and decision-making autonomy.

Civil defense is not only a structure, but also a system. The municipality is just one of the nodes in a network, of which educational institutions are also part. In the 2011 flood, as mentioned in the previous paragraph, two little girls died, and one of the mothers who had picked them up from school. This tragic event fostered a reflection on the preventive closure of school buildings in case of maximum alert and the need to train not only principals, teachers and pupils on what behavior to adopt during extreme weather phenomena, but also parents. In 2010, there had been another severe flood, which affected the western part of the city, particularly the neighborhoods of Sestri Ponente and Cornigliano. In these neighborhoods, with the most disadvantaged socio-economic conditions but with a cooperative-oriented social fabric, ward principals and administrators, in collaboration with the municipality, had developed self-regulation paths in case of heavy rain. This micro-good practice, from Sestri-Cornigliano, transferred to the whole city. Evacuation and warning plans were drawn up for each of the school buildings, developed with the support of techno-scientific facilities, such as the CIMA Foundation, which also took care of validating the measures. Schools were also, equipped with radio systems directly connected with the municipality's emergency room. The municipality, as Gianni Crivello, alderman from 2012 to 2017 for civil protection, recalls, also took preventive measures, such as the preventive closure of schools in case of red alert.

We decided that with the red alert all schools had to close. Before, this rule did not exist. We also decided that if a yellow alert turned red during school hours, each school had to know what to do. First and foremost, not to let anyone out and inform parents in advance not to go to school to pick up their children.

Again, we can identify this as an “extrapolated” good practice: from Genoa it transferred, essentially, to the rest of Italy, although the same cannot be said for the detail of the practice, starting with the plans for preparation and communication in schools. On this plane, which intersects organizational and cognitive processes, one more good practice can be situated, and that is the “civil protection pills”. It is a kit of educational units developed by an interdisciplinary team consisting of academic and municipal civil defense experts, aimed at ages 6 to 18. The kit is available to schoolteachers and consists of audio-video and informational materials on the main natural hazards to which the city is exposed and good behavior practices. The material is divided by age target. Here is the video-pill dedicated to flood risk and aimed at students in the early years of high school.

One good practice that was reported from the perspective of the municipal inter-organizational network concerns the integration, both administrative and managerial, between the civil defense and municipal police sectors, which prior to 2012 were separate. This practice, too, can be seen as an example of learning after the 2011 disaster, and as the maturation of an organisational idea that was already there, but only at the level of a niche. In particular, the civil defense operational profile consisted almost entirely of volunteers. As Monica Bocchiardo, manager of the Civil Protection sector and commander of the Municipal Police during the Doria junta (2012-2017), recounts:

After 2011, the Civil Defense sector was in tatters, due to both the emotional and judicial effects of the flood. However, we managed to rebuild the office by “merging” local police technicians and officials with civil defense ones. We moved the emergency room next to the local police operations center. This proximity not only accelerated information exchanges, but also helped create a common language. Local police, in particular, have gained more skills in reading signals and codes that anticipate disasters.

What does it mean for a traffic warden that 200 mm of rain will fall? How to understand if a river is about to overflow? Which storm drains to monitor? Where are rain gauges placed and how do you interpret their data? These are a tiny fraction of the questions that have driven the integration process between the two sectors and have strengthened the collaboration between volunteers and municipal expert operators. This organizational transformation was combined with the remodeling of the municipal operations center (COC), which the City of Genoa implemented in compliance with a guideline set by the central government. The new COC has, first, more clearly defined functions and roles during emergencies. There is a directive function, chaired by the mayor or his delegate, and consisting of the technical-administrative leadership of the municipality, based on the type of emergency. The function is also carried out in a specific physical location, to which no one other than those delegated by union ordinance to fill a role can have access. There is then an operational function, which is made up of technical and operational personnel, also located in a separate room next to the COC's management wing, accessible only to those who are part of it, from communication to weather monitoring. According to several witnesses, this reorganization, along with the land preservation system arrangement, has greatly increased the city's flood preparedness.

c. Implementational Processes

This concluding section contains what the research has focused on as good implementation practices, with specific reference to the technical-infrastructure component. Unlike the other two categories of processes, this one refers to a competence other than municipal civil protection, and more related to other sectors, such as public works and town planning. Given the large number of initiatives undertaken in this area by the Municipality of Genoa and other territorial government bodies, we will only refer to the most relevant ones in terms of effectiveness, impact and transferability.

The realisation of large hydrogeological risk prevention works (spillway, dams, stream re-covering) requires very onerous funding that is often beyond the financial possibilities of a municipality, even if it is a developed metropolitan city such as Genoa. For example, the Fereggiano stream spillway, the new covering of the Bisagno stream and the start of work on its spillway were realised thanks to state funding. However, Genoa is not the only large Italian city in need of external resources. A good practice can be located here: the development of projects regardless of the availability of resources.

This is an outcome of the basin plans, which made it possible to analyse, for each watercourse of a certain relevance that insisted on the city, the criticalities and opportunities of the context, and to indicate possible solutions, inspiring the realisation of pre-liminary projects that were useful in convincing national decision-makers. Moreover, the elaboration of the basin plans, guided by the Province and validated by the

Municipality, had anticipated the emergence of possible divergences between the two entities, and had also facilitated their resolution. This is recounted by Paolo Tizzoni:

It was 1997. Even then, floods were a topic on the institutional agenda. A public meeting was held in Genoa with the then minister Paolo Costa. As vice-president of the Province, I asked him to focus more resources on the hydrogeological risk. He replied that he would finance the projects that were already ready and on which there was agreement between the various competent institutions. Genoa had some, thanks to the basin plans. In 1998, a memorandum of understanding took shape in which the government provided 35 million euro for the construction of the spillway on the Bisagno and the covering works. Unfortunately, it was too little.

They were nevertheless instrumental in starting work on the spillway of the Fereggiano river, a tributary of the Bisagno, which crosses a densely populated area of the city and is very dangerous in the event of overflowing; also, the work to widen the Bisagno's mouth, which made it possible to 'subtract' several hundred cubic metres from the maximum flow rate of the city's most dangerous river, bringing the current flow rate closer to the 200-year maximum set by the basin plan. However, looking at the dates on which funding was granted and its implementation, it is inevitable to observe that years pass before the work is realised. Moreover, it is remarkable that the second 'wave' of funding on hydrogeological risk Genoa received after the 2014 flood, with Decree 133/2014, known as Italia Sicura: a sign that organisational learning, as far as national bodies are concerned, also depends on tragedies.

4.2.3 Divuligation

Results of Line 1 were presented in the following international research conferences and papers:

- V. Vitiello, R. Castelluccio, A.M. Zaccaria, A. Rapicano, M. Fraiese, E. Negri, G. Terenzi (2024). A methodological approach to classify good practices for urban and metropolitan risk management. *International Journal of Disaster Risk Reduction*, vol 115 <https://doi.org/10.1016/j.ijdr.2024.105069>
The contribution was awarded by the "Magna Grecia Foundation" for the rigour of its methodological approach and the public and political relevance of the topic addressed.
- V. Vitiello, M. Bosone, A. Tedeschi, M. Romano, A.M. Zaccaria, R. Castelluccio, P. De Toro, M. Leone, E. Negri, G. Terenzi, A. Rapicano, M. Fraiese, P. Galasso (2025), Classifying and assessing good practices for urban and metropolitan risk management: a methodological and evaluation framework. EGU General Assembly 2025, Vienna, Austria, 27 Apr–2 May 2025, EGU25-21774, <https://doi.org/10.5194/egusphere-egu25-21774>, 2025.
- V. Vitiello, M. Bosone, A. Tedeschi, M. Romano (2024). An inductive methodology for the construction of a core set of indicators of good practices for multi-risk management in urban and metropolitan environments. Mid-term conference of the Environment and Territory Section of the Italian Sociological Association PNRR and Territories. Participation, Transitions, Perspectives LUMSA University, 5-7 December 2024
- A.M. Zaccaria, A. Pirni, A. Peresan, R. Castelluccio, V. Vitiello, G. Tocchi, A. Rapicano, M. Fraiese, (2024). Building cities, building capacity: Mixed methods to identify Good Practices. 16th ESA Conference | 27-30 August 2024 | Porto, Portugal 54 Boulevard Raspail | Bureau A2-12 | 75006 | Paris | France SIRET 484 990 825 00024 www.europeansociology.org ISBN 978-2-9598317-0-6 | EAN 9782959831706 © European Sociological Association, December, 2024

Results of Line 2 were presented in the following international research conferences and papers:

Publication

- Marciano C., Peresan A., Pirni A., Pittore M., Tocchi G., Zaccaria A. (2024). A participatory foresight approach in disaster risk management: the multi-risk storylines. In *International Journal of Disaster Risk Reduction*. 104972, ISSN 2212-4209, <https://doi.org/10.1016/j.ijdr.2024.104972>.

International Conferences

- Marciano C., Peresan A., Pirni A., Pittore M., Tocchi G., Zaccaria A. (2024). University of Vienna. European Geoscience Union (EGU) General Assembly 2024 : *Multi-hazard risk assessments: Innovative approaches for disaster risk reduction, management, and climate change adaptation*
- Marciano C., Pirni A., Zaccaria A. (26-28 aug, 2024). Terceira (Portogallo). European Regional Studies Association (ERSA). *Floods in Italy: a research on best practices of risk learning;*
- Marciano C., Pirni A., Zaccaria A. (28 - 30 aug 2024) University of Oporto (Portugal), European Sociological Association (ESA) Conference. *Risk Storylines. A new methodological tool for risk management.*
- Marciano C., Pirni A. (03 Sept, 2025). Eurac Research. *Risk Storylines. A new methodological tool for risk management.*
- Marciano C., Pirni A (08-10 Sept, 2025). University of Turin, Annual Conference of Italian Sociological Association, Environmental Section. *Floods and Metropolitan Context. The organizational learning in Genoa after the 2011 and 2014 floods.*
- Marciano C., Pirni A. (25-27 Sept, 2025). Energy and Society, Conference of Environmental Sociology section of European Sociological Association. *Floods and Metropolitan Context. The organizational learning in Genoa after the 2011 and 2014 floods.*

5. Conclusions

The two lines of work are progressively reaching a result that could constitute a methodology for the identification of potentially "good" practices. In particular, it is believed that the development of a self-assessment tool could be encouraged: a sort of check list to be released to institutional actors, in particular for the decision-making ecosystem. However, follow-ups are necessary for both lines of work.

5.1. Follow up line 1

The results of work line 1 led to the development of 132 indicators to assess the effectiveness of a Practice for Multi-Hazard Management at urban and metropolitan level.

The methodology developed revealed a number of strengths that motivate the continuation of the work, in particular regarding the involvement of knowledge stakeholders, internal to the RETURN project, with multidisciplinary backgrounds that fostered a broad debate related to the different weight given by each expert to the indicators identified.

For this reason, an interest in carrying out a multi-criteria analysis was found: by evaluating the weight expressed by each expert to each indicator, in terms of relevance of the indicator for the purposes of defining a practice as 'Good Practice', the WG aims at identifying the *essentials*, i.e. the core-set of indicators that must be compulsorily fulfilled by a Practice in order to be defined as a 'Good Practice for multi-hazard management at urban and metropolitan level'.

To this end, continuing the working synergy with the experts of Spoke VS3, 11 experts participating in the RETURN project were involved, representing expertise in topics such as building construction, sociology, environmental design of architecture, and appraisal and valuation. The work was carried out through a very thorough analysis of the 132 indicators, which also led to the rewriting of some of them in line with the objectives of the RETURN project, and the synthesis and elimination of others that were considered inconsistent with the research objectives. The approach adopted involved a series of meetings and focus groups during which the experts discussed and justified their personal positions on each of the observations made on the indicators, which were analysed one by one, until they reached agreement on the revisions to be made, which then incorporated scientific and disciplinary approaches from various areas of multi-risk research. As a result of this work, the list of good practice indicators identified 9 criteria and 79 indicators.

In addition, forms were prepared to be submitted to internal and external stakeholders, selected from the various social, technical and political actors involved in the development of the case studies, so that each one, according to their expertise, would attribute a scale of relevance to each indicator.
<https://forms.office.com/e/OA9KYG3jpv>

The follow-up of the research, therefore, involved the following steps:

Step 3: knowledge Stakeholders, internal to the RETURN project, representatives of all WPs of TS1 and some of the VS3, were invited to assign a relevance value to the developed indicators for each criterion. The same process will be extended to groups of Stakeholders external to the RETURN project. The 79 indicators obtained can be considered the RETURN core set indicators.

Step 4 : Field Testing of the Methodology (Rapicano, Zaccaria and Peresan), aimed at evaluating social vulnerability parameters in the Friulian context, considered as a significant pilot case due to its multi-risk exposure and complex socio-demographic dynamics. The methodology adopted in this phase represents an attempt to re-apply the framework previously developed (Vitiello et al, 2024). Through a structured mapping of key sources in disaster studies and urban resilience, abstract constructs were translated into dimensions, indicators, and items suitable for measurement (7-point Likert scale), covering five areas: environment & territory; demography & population structure; family/socio-territorial profile; housing conditions; access to services and opportunities. The field test focused on the domain of social vulnerability assessment, aiming to verify the applicability of the published framework in a different scale and thematic focus. Preliminary results confirmed that the methodology can be adapted to local needs and provides an effective basis for identifying good practices in disaster risk management. Moreover, the field test highlighted both strengths (clarity, usability, replicability) and areas for improvement (simplification of technical items, integration of qualitative evidence).

Finally, as a result of this follow-up, RETURN core set indicators were identified, representing a valuable tool for testing multi-risk management practices, classifying them and identifying areas where their effectiveness can be improved or implemented.

They can be applied for the assessment of different practices thus identifying a classification rule for the repository of good practices for multi-risk management that can be applied in every specific real-world context.

One possible classification of practices distinguishes between:

- *Validated Good Practice*, which meets the core-set indicators, and have already been applied or validated, demonstrating their effectiveness.
- *Promising Good Practice*, which meets the core-set indicators, but has not yet been applied or validated in practice.
- *Sector Good Practice* that, while meeting the core-set indicators, can only be applied in specific risk scenarios and not across multi-risk scenarios.
- *Context Good Practice* that, while meeting the core-set indicators, can only be applied in a specific reference context and may not be generalizable to other settings.

For the purposes of the RETURN project, it is considered beneficial that the methodology is open, as it allows for the analysis and classification of practices developed within the project itself, creating a tool for self-assessment of the project's results and their replicability and applicability in different contexts.

The RETURN core set indicators represent a valuable tool for testing multi-risk management practices, classifying them and identifying areas where their effectiveness can be improved or implemented. In this sense, the research results provide public decision-makers with a practical and useful tool for evaluating existing practices and planning the most resilient risk reduction and management strategies.

5.1. Follow up line 2

4.2. Background

As part of the activities carried out in WP6, the research team conducted an in-depth theoretical study on organisational and inter-organisational learning, with particular reference to the neo-institutionalist sociology of organisations (Levitt & March, 1989; Turner, 2006). This exploration stemmed from fieldwork showing that most good practices in Genoa were developed in the period between two major flood events (2011 and 2014) and up to 2019, the year of the *Ponte Morandi* tragedy (and later the Covid-19 emergency).

The research sought to understand why a specific organisation — the Municipality of Genoa — concentrated greater resources and attention during that phase, and not before or after those events. To address this question, the team analysed which institutional and social factors create the conditions for learning. Preliminary results indicate three interrelated dimensions: learning related to the event; learning related to the broader context; and learning related to the organisation itself.

- **Severity and recurrence of events:** most mitigation and prevention actions were concentrated between 2012 and 2017, following two severe floods (2011 and 2014). The recurrence of previous floods (four since 1992) also reshaped interpretive frames.

- **Loss of memory due to temporal distance:** interviewees reported a “relaxation” of attention over time, partly because of the elapsed time since the last major event and, paradoxically, because of the effectiveness of mitigation measures.
- **Sanctioning mechanisms:** administrators and technicians were investigated and later convicted for failures in DRM. After the 2014 flood, a national policy on weather alerts was introduced, alongside new funding for the Bisagno diversion tunnel (still under construction).
- **Moral reserve and civic mobilisation:** after 2011, committees and associations — especially in neighbourhoods along the Bisagno — built consensus around DRM measures. Media coverage amplified the narrative of administrative and managerial shortcomings.
- **Shift in political relevance of DRM:** hydrological risk management, under pressure from events and public debate, became a key theme in local political legitimacy, increasing the allocation of financial and human resources.
- **“Coercive” learning:** a binding procedure was established to align responsibilities and competences between the Region and the Municipality for alert management at the national level.
- **Availability of external funding:** large hydraulic engineering works (e.g., the diversion tunnel), beyond municipal budgets, were financed through the *Italia Sicura* programme, accelerating organisational and cognitive processes.

Further research within WP6 mapped and engaged stakeholders of Genoa’s local civil protection system through storylines and semi-structured interviews. Decision-makers were joined by voices from other organisations playing a significant role in civil protection: associations with agreements with the Municipality and the Region, professional associations, environmental NGOs, and third-sector representatives. This broader perspective will allow WP6 to extend the analysis of learning from the municipal level to the wider socio-technical system underpinning local DRM.

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Annex – Criteria elaborated and related indicators

Table C.1. Criterion 1: Risk dimensions

Variables	Indicators	Measurement unit	Cluster 1 _ Measurability	Cluster 2 _ Dimension	Cluster 3 _ Sendai Priorities	How to measure/evaluate
How many risk dimensions are analysed?	Number of risk dimensions analysed	no.	Quantitative	Overarching	Understanding disaster risk governance	Analysis of the plan
Which types of risk dimensions are analysed?	Types of risk dimensions	select one	Qualitative	Overarching	Understanding disaster risk governance	Analysis of the plan
Do the city governance measures include and implement disaster risk reduction (DRR) approaches in multi-risk scenarios due to climate change?	Presence of DRR approaches due to climate change in governance measures	y/n	Qualitative	Overarching	Overarching	Number and type of approaches
Does the city have maps to evaluate the consistency of built heritage, updated within the last 5 years?	Presence of maps to evaluate the consistency of built heritage, updated within the last 5 years	y/n	Qualitative	Overarching	Understanding disaster risk governance	Analysis of the plan
Does the city have maps to evaluate the consistency of informal settlements, updated within the last 5 years?	Presence of maps to evaluate the consistency of informal settlements, updated within the last 5 years	y/n	Qualitative	Overarching	Understanding disaster risk governance	Analysis of the plan
If yes, which types of informal settlements have been recorded?	Types of informal settlements recorded	select one	Qualitative	Overarching	Understanding disaster risk governance	Analysis of the plan



What percentage of informal settlements has been recorded?	Percentage of informal settlements recorded	%	Quantitative	Overarching	Understanding disaster risk governance	Analysis of the plan
Does the city have maps to evaluate the consistency of green spaces, updated within the last 5 years?	Presence of maps to evaluate the consistency of green spaces, updated within the last 5 years	y/n	Qualitative	Overarching	Understanding disaster risk governance	Analysis of the plan
Does the city have maps to evaluate the consistency of open spaces, updated within the last 5 years?	Presence of maps to evaluate the consistency of open spaces, updated within the last 5 years	y/n	Qualitative	Overarching	Understanding disaster risk governance	Analysis of the plan
Does the city have lists of skills needed to face the identified risk scenarios?	Presence of lists of skills needed to face the identified risk scenarios	y/n	Qualitative	Overarching	Understanding disaster risk governance	Analysis of the plan and policies
If yes, which types of skills have been identified?	Types of skills identified	select one	Qualitative	Overarching	Understanding disaster risk governance	Analysis of the plan and policies
Does the city have maps to evaluate the percentage of high-risk urban areas where development is restricted or prohibited under planning guidelines?	Presence of maps to evaluate the percentage of high-risk urban areas where development is restricted or prohibited under planning guidelines	y/n	Qualitative	Overarching	Understanding disaster risk governance	Analysis of the plan and policies
Does the city have a catalogue of past hazard events?	Catalogue of past hazard events	y/n	Qualitative	Overarching	Understanding disaster risk governance	Analysis of the plan and policies
If yes, does the catalogue include the impact assessment for the past hazard events?	Presence of impact assessment for past events	y/n	Qualitative	Overarching	Understanding disaster risk governance	Analysis of the plan and policies

Table C.2. Criterion 2: Ecosystem services, structures and green and blue infrastructures

Variables	Indicators	Measurement unit	Cluster 1 _ Measurability	Cluster 2 _ Dimension	Cluster 3 _ Sendai Priorities	How to measure/evaluate
Does the city have a comprehensive catalogue of infrastructures?	Presence of a comprehensive catalogue of infrastructures	y/n	Qualitative	Infrastructure	Understanding disaster risk governance	Analysis of the plan
For which public services does the city have insurance measures?	Public services insured	multiple choice	Qualitative	Economic	Investing in disaster risk reduction for resilience	Public budget analysis
For which infrastructures does the city have insurance measures?	Infrastructures insured	multiple choice	Qualitative	Economic	Investing in disaster risk reduction for resilience	Public budget analysis
Does the city have protective infrastructures to face relevant risks?	Presence of protective infrastructures to face relevant risks?	y/n	Qualitative	Economic	Investing in disaster risk reduction for resilience	Public budget analysis
If yes, are all the protective infrastructures in place, monitored consistent with relevant risks?	Presence of a monitoring plan of the protective infrastructures in place consistent with relevant risks	y/n	Qualitative	Infrastructure	Understanding disaster risk governance	Infrastructure plan and public budget analysis
How frequently is the city-wide adequacy of the protective infrastructures reviewed?	Revision frequency of city-wide adequacy of the protective infrastructures	single choice	Quantitative	Infrastructure	Understanding disaster risk governance	Infrastructure plan and public budget analysis
Are all the protective infrastructures in place, maintained consistent with relevant risk?	Presence of a maintenance plan of the protective infrastructures in place consistent with relevant risk	y/n	Qualitative	Infrastructure	Understanding disaster risk governance	Infrastructure plan and public budget analysis
Within how many hours can the 90% of injuries be treated in the most severe scenario?	Hours within the 90% of injuries can be treated in the most severe scenario	single choice	Quantitative	Infrastructure	Understanding disaster risk governance	Infrastructure plan

Does the city have multiple sources providing at least 5% of the supply?	Presence of multiple sources providing at least 5% of the supply	y/n	Qualitative	Infrastructure	Understanding disaster risk governance	Infrastructure plan
If yes, which types of multiple sources?	Types of multiple sources	multiple choice	Qualitative	Infrastructure	Understanding disaster risk governance	Infrastructure plan
Does the city have a long-term plan for comprehensive waste disposal management, updated within the last 5 years?	Presence of a long-term plan for comprehensive waste disposal management, updated within the last 5 years	y/n	Qualitative	Infrastructure	Understanding disaster risk governance	Infrastructure plan, public budget analysis
				Environmental		
				Ecological		
What is the percentage range of teaching facilities still working in the "most severe" scenario?	Percentage range of teaching facilities still working in the "most severe" scenario	single choice	Quantitative	Infrastructure	Strengthening disaster risk governance	Impact scenarios analysis
Which types of first response assets have been evaluated to be adequate in practice to deal with a "most severe" scenario?	Types of first response assets evaluated to be adequate in practice to deal with a "most severe" scenario	multiple choice	Qualitative	Infrastructure	Strengthening disaster risk governance	Impact scenarios analysis
Does the city have maps evaluating escape routes, updated within 5 years?	Presence of maps evaluating escape routes, updated within 5 years	y/n	Qualitative	Infrastructure	Understanding disaster risk governance	Infrastructure plan
					Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
If yes, which information does this map consider?	Type of information considered	multiple choice	Qualitative	Infrastructure	Understanding disaster risk governance	Infrastructure plan
					Enhancing disaster preparedness for effective response and	

					to build back better in recovery, rehabilitation and reconstruction	
Does the city monitor the efficiency of public transport compliance with the escape scenario?	Presence of a monitoring plan for the efficiency of public transport compliance with the escape scenario	y/n	Qualitative	Infrastructure	Strengthening disaster risk governance	Infrastructure plan
Does the city have structures dedicated to psychological support during and after the hazard event?	Presence of structures dedicated to psychological support during and after the hazardous event	y/n	Qualitative	Social	Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	Analysis of the plan Scenario analysis Typology
Does the city have policies promoting green and blue infrastructures?	Presence of policies promoting green and blue infrastructures	y/n	Qualitative	Infrastructure	Strengthening disaster risk governance	Infrastructure plan, impact scenarios
				Environmental		
				Ecological		
				Politic	Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
If yes, which percentage of the public budget the city allocates for green and blue infrastructures?	Percentage of the public budget allocated for green and blue infrastructures	%	Quantitative	Economic	Investing in disaster risk reduction for resilience	Infrastructure plan, public budget analysis
				Environmental		
				Ecological		
What is the percentage of the population over 75 years with difficulties in accessing services?	Percentage of population over 75 years with difficulties in accessing services	%	Quantitative	Infrastructure	Understanding disaster risk governance	statistic sources of Municipality
				Social	Strengthening disaster risk governance	

What is the percentage of the population under 75 years with difficulties in accessing services?	Percentage of population under 75 years with difficulties in accessing services	%	Quantitative	Infrastructure	Understanding disaster risk governance	statistic sources of Municipality
				Social	Strengthening disaster risk governance	
Does the city have services immediately available to face alert scenarios?	Presence of a list of resources immediately available to face alert scenarios	y/n	Qualitative	Overarching	Understanding disaster risk governance	Analysis of the plan and policies
If yes, which type of services are immediately available?	Type of services immediately available	multiple choice	Qualitative	Overarching	Understanding disaster risk governance	Analysis of the plan and policies

Table C.3. Criterion 3: Practices validation and update

Variables	Indicators	Measurement unit	Cluster 1 _ Measurability	Cluster 2 _ Dimension	Cluster 3 _ Sendai Priorities	How to measure/evaluate
Does the city have validated tools for pre-disaster assessment?	Presence of validated tools for pre-disaster assessment	y/n	Qualitative	Politic	Understanding disaster risk governance	Analysis of the plan
If yes, which types of validated tools are used?	Types of validated tools used for pre-disaster assessment	multiple choice	Qualitative	Politic	Understanding disaster risk governance	Analysis of the plan
Does the city update multi-hazard maps at least every 5 years?	Update of multi-hazard maps at least every 5 years	y/n	Qualitative	Overarching	Understanding disaster risk governance	Analysis of the plan
					Strengthening disaster risk governance	
Does the city update land use maps at least every 5 years?	Update of land use maps at least every 5 years	y/n	Qualitative	Overarching	Understanding disaster risk governance	Analysis of the plan
Does the city have standards verified at least every 5 years	Presence of standards verified at	y/n	Qualitative	Overarching	Understanding disaster risk governance	Analysis of the plan

addressing all multi-risk scenarios?	least every 5 years addressing all multi-risk scenarios					
Does the city have disaster management plans for all multi-risk scenarios?	Presence of disaster management plans for all multi-risk scenarios	y/n	Qualitative	Overarching	Understanding disaster risk governance	Analysis of the plan
					Strengthening disaster risk governance	
Are disaster management plans validated at least every 5 years for all multi-risk scenarios?	Validation of disaster management plans at least every 5 years for all multi-risk scenarios	y/n	Qualitative	Overarching	Understanding disaster risk governance	Analysis of the plan
					Strengthening disaster risk governance	
Does the city have preparedness plans available for all multi-risk scenarios?	Presence of preparedness plans for all multi-risk scenarios	y/n	Qualitative	Overarching	Understanding disaster risk governance	Analysis of the plan
					Strengthening disaster risk governance	
Are preparedness plans validated at least every 5 years for all multi-risk scenarios?	Validation of preparedness plans validated at least every 5 years for all multi-risk scenarios	y/n	Qualitative	Overarching	Understanding disaster risk governance	Analysis of the plan
					Strengthening disaster risk governance	
Does the city have emergency response plans for all multi-risk scenarios?	Presence of emergency response plans for all multi-risk scenarios	y/n	Qualitative	Overarching	Understanding disaster risk governance	Analysis of the plan
					Strengthening disaster risk governance	
Are emergency response plans validated at least every 5 years for all multi-risk scenarios?	Validation of emergency response plans at least every 5 years for all multi-risk scenarios	y/n	Qualitative	Overarching	Understanding disaster risk governance	Analysis of the plan
					Strengthening disaster risk governance	
Has the city conducted at least one practice	Presence of one practice drill each	y/n	Qualitative	Overarching	Understanding disaster risk governance	Database

drill each year in the last 5 years?	year in the last 5 years				Strengthening disaster risk governance	
Has the city tested practice drills' efficacy in the last 5 years?	Presence of testing of practice drills efficacy in the last 5 years	y/n	Qualitative	Overarching	Understanding disaster risk governance	Database
					Strengthening disaster risk governance	
If yes, how practice drills have been tested?	Types of methods used for testing practice drills	multiple choice	Qualitative	Overarching	Understanding disaster risk governance	Database
					Strengthening disaster risk governance	
Does the city have the provision of buildings for temporary housing (shelters) after a hazard event?	Provision of buildings for temporary housing (shelters) after a hazardous event	y/n	Qualitative	Overarching	Understanding disaster risk governance	Analysis of the plan
					Strengthening disaster risk governance	
					Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
If yes, is the number of buildings for temporary housing (shelters) after a hazard event adequate in the most severe scenario?	Adequacy of the number of buildings for temporary housing (shelters) after a hazard event with the most severe scenario	y/n	Qualitative	Infrastructure	Understanding disaster risk governance	Analysis of the plan
					Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
Does the city have the provision of buildings for permanent housing	Provision of buildings for permanent	y/n	Qualitative	Overarching	Understanding disaster risk governance	Analysis of the plan

(shelters) after a hazard event?	housing (shelters) after a hazardous event				Strengthening disaster risk governance	
					Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
If yes, is the number of buildings for permanent housing (shelters) after a hazard event adequate in the most severe scenario?	Adequacy of the number of buildings for permanent housing (shelters) after a hazard event with the most severe scenario	y/n	Qualitative	Infrastructure	Understanding disaster risk governance	Analysis of the plan
					Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
Does the city have the provision of areas for temporary housing (shelters) after a hazard event?	Provision of areas for temporary housing (shelters) after a hazardous event	y/n	Qualitative	Overarching	Understanding disaster risk governance	Analysis of the plan
					Strengthening disaster risk governance	
					Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	



If yes, is the number of areas for temporary housing (shelters) after a hazard event adequate in the most severe scenario?	Adequacy of the number of areas for temporary housing (shelters) after a hazard event with the most severe scenario	y/n	Qualitative	Infrastructure	Understanding disaster risk governance	Analysis of the plan
					Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
Does the city have the provision of areas for permanent housing (shelters) after a hazard event?	Provision of areas for permanent housing (shelters) after a hazard event	y/n	Qualitative	Overarching	Understanding disaster risk governance	Analysis of the plan
					Strengthening disaster risk governance	
					Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
If yes, is the number of areas for permanent housing (shelters) after a hazard event adequate in the most severe scenario?	Adequacy of the number of areas for permanent housing (shelters) after a hazard event with the most severe scenario	y/n	Qualitative	Infrastructure	Understanding disaster risk governance	Analysis of the plan
					Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
Does the city have a secure backup remote storage for city government data within the DRR databases?	Presence of a secure backup remote storage for city government data within the DRR databases	y/n	Qualitative	Infrastructure	Strengthening disaster risk governance	Analysis of the plan
					Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	Analysis of the plan

Table C.4. Criterion 4: System of Stakeholders / Policymakers

Variables	Indicators	Measurement unit	Cluster 1 _ Measurability	Cluster 2 _ Dimension	Cluster 3 _ Sendai Priorities	How to measure/evaluate
Does the city have a formalized partnership with Stakeholders?	Presence of a formalized partnership with Stakeholders	y/n	Qualitative	Overarching	Overarching	Analysis of the plan
Are Stakeholders involved in all the phases of DRR decision-making?	Involvement of Stakeholders in all the phases of DRR decision-making	y/n	Qualitative	Overarching	Overarching	Analysis of the plan
How many Stakeholder categories are involved in DRR planning?	Number of Stakeholders categories involved in DRR planning	no.	Quantitative	Overarching	Overarching	Analysis of the plan Scenario analysis Typology
Which types of Stakeholder categories are involved in DRR planning?	Types of Stakeholders categories involved in DRR planning	multiple choice	Qualitative	Overarching	Overarching	Analysis of the plan Scenario analysis Typology
Do Stakeholders identify the type of resources given for supporting DRR planning in the agreement?	Identification of the type of resources given by Stakeholders for supporting DRR planning in the agreement	y/n	Qualitative	Overarching	Overarching	Analysis of the plan Scenario analysis Typology
If yes, which types of resources given for supporting DRR planning are identified in the agreement?	Types of resources given for supporting DRR planning are identified in the agreement	multiple choice	Qualitative	Overarching	Overarching	Analysis of the plan Scenario analysis Typology
How often have DRR decision-making processes involved Stakeholders during the last 5 years?	Frequency of Stakeholder involvement in DRR decision-making processes	single choice	Qualitative	Politic	Strengthening disaster risk governance	Institutional sources/service conferences and similar secondary sources

	during the last 5 years					
Does the city have a formalized partnership with research organisations?	Presence of formalized partnerships with research organisations	y/n	Qualitative	Overarching	Overarching	Institutional sources/service conferences and similar secondary sources
If yes, which types of research organizations are involved?	Types of research organizations involved	multiple choice	Qualitative	Overarching	Overarching	Institutional sources/service conferences and similar secondary sources
Does the city have a database of structured volunteer organisations, updated within the last 5 years?	Presence of a database of structured volunteer organisations, updated within the last 5 years	y/n	Qualitative	Infrastructure	Understanding disaster risk governance	Analysis of the plan
Does the city have a database of the resources that the volunteer organisation gives in support, updated within the last 5 years?	Presence of a database of the resources that volunteer organisation gives in support, updated within the last 5 years	y/n	Qualitative	Infrastructure	Understanding disaster risk governance	Analysis of the plan

Table C.5. Criterion 5: Empowerment of vulnerable groups

Variables	Indicators	Measurement unit	Cluster 1 _ Measurability	Cluster 2 _ Dimension	Cluster 3 _ Sendai Priorities	How to measure/evaluate
Does the city have a database of vulnerable groups, updated within the last 5 years?	Presence of a database of vulnerable groups, updated within the last 5 years	y/n	Qualitative	Social	Understanding disaster risk governance	Database consultation, analysis, community profiles
If yes, which types of vulnerable groups have been identified?	Types of vulnerable groups identified	multiple choice	Qualitative	Social	Understanding disaster risk governance	Database consultation, analysis, community profiles
Does the city have a map of zones of vulnerable groups' concentration, updated within the last 5 years?	Presence of a map of zones of vulnerable groups' concentration, updated within the last 5 years	y/n	Qualitative	Social	Understanding disaster risk governance	Database consultation/analysis
If yes, which types of zones have been identified?	Types of zones identified	multiple choice	Qualitative	Social	Understanding disaster risk governance	Database consultation/analysis
Are vulnerable groups considered within the development of DRR plans?	Consideration of vulnerable groups within DRR plans	y/n	Qualitative	Social	Understanding disaster risk governance	Analysis of the plan Scenario analysis Typology
If yes, which types of vulnerable groups are considered within the development of DRR plans?	Types of vulnerable groups considered within DRR plans	multiple choice	Qualitative	Social	Understanding disaster risk governance	Analysis of the plan Scenario analysis Typology
What is the average per capita income of the city's residents?	Per capita income of the city's residents	€/year	Quantitative	Economic	Understanding disaster risk governance	Population database
				Social		

Table C.6. Criterion 6: Public communication

Variables	Indicators	Measurement unit	Cluster 1 _ Measurability	Cluster 2 _ Dimension	Cluster 3 _ Sendai Priorities	How to measure/evaluate
How many public events have been organised related to DRR in the last 5 years?	Number of public events related to DRR organised in the last 5 years	no.	Quantitative	Social	Strengthening disaster risk governance	Media; institutional websites; and other secondary sources
					Investing in disaster risk reduction for resilience	
			Cultural	Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction		
Which types of public events have been organised related to DRR in the last 5 years?	Types of public events related to DRR organised in the last 5 years	multiple choice	Qualitative	Cultural	Strengthening disaster risk governance	Media; institutional websites; and other secondary sources
					Investing in disaster risk reduction for resilience	
					Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
Does the city have guidelines for practitioners (e.g. architects, landscape architects, engineers, etc)?	Presence of guidelines for practitioners	y/n	Qualitative	Politic	Strengthening disaster risk governance	Analysis of the plan Scenario analysis Typology
					Enhancing disaster preparedness for effective response and to build back better in	

					recovery, rehabilitation and reconstruction	
Does the city have assessment tools for risk communication campaign efficacy?	Presence of assessment tools for risk communication campaign efficacy	y/n	Qualitative	Politic	Strengthening disaster risk governance Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	Analysis of the plan Scenario analysis Typology
If yes, which types of assessment tools for risk communication campaign efficacy are used?	Types of assessment tools for risk communication campaigns efficacy used	multiple choice	Qualitative	Politic	Strengthening disaster risk governance Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	Analysis of the plan Scenario analysis Typology
Does the city have tools to measure how many people have been reached by risk communication campaigns?	Presence of tools to measure how many people have been reached by risk communication campaigns	y/n	Qualitative	Politic	Strengthening disaster risk governance Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	Analysis of the plan Scenario analysis Typology
If yes, which types of tools to measure how many people have	Types of tools to measure how many	multiple choice	Qualitative	Politic	Strengthening disaster risk governance	Analysis of the plan Scenario analysis Typology

<p>been reached by risk communication campaigns are used?</p>	<p>people have been reached by risk communication campaigns are used</p>				<p>Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction</p>	
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Does the city have an open-access web portal regarding DRR?	Presence of an open-access web portal regarding DRR	y/n	Qualitative	Cultural	Strengthening disaster risk governance	Media; institutional websites; and other secondary sources
				Politic	Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
If yes, which types of information does the web portal contain?	Types of information contained in the web portal	multiple choice	Qualitative	Cultural	Strengthening disaster risk governance	Media; institutional websites; and other secondary sources
				Politic	Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
If yes, does the city conduct a periodical monitoring of accesses to the web portal regarding DRR?	Presence of a periodical monitoring of accesses to the web portal regarding DRR	y/n	Qualitative	Cultural	Strengthening disaster risk governance	Media; institutional websites; and other secondary sources
				Politic	Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
Does the city have instruments to assess the population's risk perception?	Presence of instruments to assess the population's risk perception	y/n	Qualitative	Politic	Understanding disaster risk governance	Analysis of the communication plan
If yes, which types of instruments does the city use to assess the population's risk perception?	Types of instruments used to assess the population's risk perception	multiple choice	Qualitative	Politic	Understanding disaster risk governance	Analysis of the communication plan
Which types of media channels are used to alert people during an emergency?	Types of media channels used to alert people during the emergency	multiple choice	Qualitative	Cultural	Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	Analysis of the communication plan; DPC interviews and confrontation.
Does the city have online communication materials produced in different languages used in the city?	Presence of online communication materials produced in different	y/n	Qualitative	Social	Enhancing disaster preparedness for effective response and to build back better in recovery,	Analysis of the communication plan; DPC interviews and confrontation.

	languages used in the city				rehabilitation and reconstruction	
Does the city have off-line communication materials produced in different languages used in the city	Presence of off-line communication materials produced in different languages used in the city	y/n	Qualitative	Social	Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	Analysis of the communication plan; DPC interviews and confrontation.

Table C.7. Criterion 7: Training

Variables	Indicators	Measurement unit	Cluster 1 _ Measurability	Cluster 2 _ Dimension	Cluster 3 _ Sendai Priorities	How to measure/evaluate
How many training public events have been organised during the last 5 years?	Number of training public events organised during the last 5 years	no.	Quantitative	Social	Strengthening disaster risk governance Investing in disaster risk reduction for resilience	Media; institutional websites; and other secondary sources
				Cultural	Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
Which types of training public events have been organised during the last 5 years?	Types of training public events organised during the last 5 years	multiple choice	Qualitative	Cultural	Strengthening disaster risk governance Investing in disaster risk reduction for resilience Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	Media; institutional websites; and other secondary sources
Does the city have risk training initiatives?	Presence of risk training initiatives	y/n	Qualitative	Cultural	Strengthening disaster risk governance	Analysis of the plan Scenario analysis Typology
				Social	Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
If yes, which types of risk training initiatives are organised?	Types of risk training initiatives organised	multiple choice	Qualitative	Cultural	Strengthening disaster risk governance	Analysis of the plan Scenario analysis Typology
				Social	Enhancing disaster preparedness for effective response and to build back better in recovery,	

					rehabilitation and reconstruction	
Does the city have training agreements with other territories?	Presence of training agreements with other territories	y/n	Qualitative	Politic	Strengthening disaster risk governance	Institutional sources; service conferences and similar secondary sources;
					Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
If yes, at which governance level have training agreements been signed?	Governance level of training agreements signed	multiple choice	Qualitative	Politic	Strengthening disaster risk governance	Institutional sources; service conferences and similar secondary sources;
					Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
Does the city participate in training courses organised by other subjects?	Participation in training courses organised by other subjects	y/n	Qualitative	Politic	Strengthening disaster risk governance	Institutional sources; service conferences and similar secondary sources;
					Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
If yes, which types of subjects organise training courses?	Types of subjects organizing training courses	multiple choice	Qualitative	Politic	Strengthening disaster risk governance	Institutional sources; service conferences and similar secondary sources;
					Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
Does the city have an annual fund for public training on disaster governance?	Presence of an annual fund for public training on disaster governance	y/n	Qualitative	Economic	Investing in disaster risk reduction for resilience	budget, training programmes
				Politic	Strengthening disaster risk governance	



If yes, what is the amount of the annual fund per inhabitant?	Amount of the annual fund per inhabitant	€/ no. of inhabitants	Quantitative	Economic	Investing in disaster risk reduction for resilience	budget, training programmes
				Politic	Strengthening disaster risk governance	
Has the city participated in training events during the last 5 years?	Participation in training events during the last 5 years	y/n	Qualitative	Politic	Strengthening disaster risk governance	Institutional sources;
					Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
If yes, has the city implemented the results of training events in the design of DRR strategies?	Implementation of training events results in the design of DRR strategies	y/n	Qualitative	Politic	Strengthening disaster risk governance	Institutional sources; Analysis of plans
					Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
What are the main results of training events implemented in the design of DRR strategies?	Main results of training events implemented in the design of DRR strategies	multiple choice	Qualitative	Politic	Strengthening disaster risk governance	Institutional sources; Analysis of plans
					Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	

Table C.8. Criterion 8: Economic measures stored/invested for public and private resilience

Variables	Indicators	Measurement unit	Cluster 1 _ Measurability	Cluster 2 _ Dimension	Cluster 3 _ Sendai Priorities	How to measure/evaluate
Does the city have financial resources dedicated to risk management in its last validated public budget?	Presence of financial resources dedicated to risk management in its public budget	y/n	Qualitative	Economic	Investing in disaster risk reduction for resilience	Analysis of economic plans
If yes, what percentage of funding is covered by the municipality for DRR?	Percentage of funding covered by the municipality for DRR	%	Quantitative	Politic	Investing in disaster risk reduction for resilience	Analysis of economic plans
				Economic		
Does the city have financial instruments incentivising DRR?	Presence of financial instruments incentivising DRR	y/n	Qualitative	Politic	Investing in disaster risk reduction for resilience	Analysis of economic plans
				Economic	Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
If yes, which financial instruments does the city have?	Financial instruments incentivising DRR	multiple choice	Quantitative	Economic	Investing in disaster risk reduction for resilience	Analysis of economic plans
					Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
What percentage of the last validated	Percentage of the budget	%	Quantitative	Economic	Investing in disaster risk	



public budget is allocated by the city for infrastructure maintenance?	allocated by the city for infrastructure maintenance					reduction for resilience	Analysis of economic plans
						Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
What percentage of the last validated public budget is allocated by the city for infrastructure monitoring?	Percentage of the budget allocated by the city for infrastructure monitoring	%	Quantitative	Economic		Investing in disaster risk reduction for resilience	Analysis of economic plans
						Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
What percentage of the last validated public budget is allocated by the city for public building maintenance?	Percentage of the budget allocated by the city for public building maintenance	%	Quantitative	Economic		Investing in disaster risk reduction for resilience	Analysis of economic plans
						Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
What percentage of the last validated public budget is allocated by the city for public building monitoring?	Percentage of the budget allocated by the city for public building monitoring	%	Quantitative	Economic		Investing in disaster risk reduction for resilience	Analysis of economic plans
						Enhancing disaster preparedness for effective response and to build back	

					better in recovery, rehabilitation and reconstruction	
What percentage of the last validated public budget is allocated by the city for services maintenance?	Percentage of the budget allocated by the city for services maintenance	%	Quantitative	Economic	Investing in disaster risk reduction for resilience	Analysis of economic plans
					Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
What percentage of the last validated public budget is allocated by the city for services monitoring?	Percentage of the budget allocated by the city for services monitoring	%	Quantitative	Economic	Investing in disaster risk reduction for resilience	Analysis of economic plans
					Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
What percentage of the last validated public budget is allocated by the city for householders' monitoring?	Percentage of the budget allocated by the city for householders monitoring	%	Quantitative	Economic	Investing in disaster risk reduction for resilience	Analysis of economic plans
					Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
What percentage of the last validated	Percentage of the budget	%	Quantitative	Economic	Investing in disaster risk	



public budget is allocated by the city for householders' maintenance?	allocated by the city for householders' maintenance				reduction for resilience	Analysis of economic plans
					Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	
How often DRR financial plans are updated?	Frequency of financial plan updating	single choice	Qualitative	Economic	Strengthening disaster risk governance	Analysis of economic plans
In case of a recent disaster event, did the city register the amount of expenditure incurred in the emergency management phase?	Registration of the amount of expenditure incurred in the emergency management phase	y/n	Qualitative	Economic	Investing in disaster risk reduction for resilience	Analysis of economic plans
Did the city cover the emergency management phase during the last recent disaster event with an internal budget?	Emergency management phase during the last recent disaster event covered with internal budget	y/n	Quantitative	Economic	Investing in disaster risk reduction for resilience	Analysis of economic plans
If yes, what percentage of the internal budget covers the expenditure?	Percentage of internal budget used to cover the expenditure	%	Quantitative	Economic	Investing in disaster risk reduction for resilience	Analysis of economic plans
Does the city have a budget for emergency services?	Presence of a budget measure	y/n	Qualitative	Economic	Investing in disaster risk reduction for resilience	Infrastructure plan, public budget analysis
If yes, what is the percentage range covered by the budget in the most severe scenario considered?	Percentage range of the budget consistent with the most severe scenario considered	single choice	Quantitative	Economic	Investing in disaster risk reduction for resilience	Analysis of economic plans



Table C.9. Criterion 9: Community engagement and social capital

Variables	Indicators	Measurement unit	Cluster 1 _ Measurability	Cluster 2 _ Dimension	Cluster 3 _ Sendai Priorities	How to measure/evaluate
Do community organizations participate in DRR planning?	Participation of community organizations in DRR planning	y/n	Qualitative	Social	Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	Analysis of plans; stakeholders engagement activities (i.e., interviews)
				Politic	Strengthening disaster risk governance	
Are community organizations engaged through multiple media channels?	Engagement of community organizations through multiple media channels	y/n	Qualitative	Politic	Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	Stakeholders' engagement activities (i.e., interviews; focus groups)
				Social	Strengthening disaster risk governance	
Which media channels are most used to engage the community?	Media channels most used to engage the community	multiple choice	Qualitative	Social	Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	Stakeholders' engagement activities (i.e., interviews; focus groups)
					Strengthening disaster risk governance	
What is the percentage range of the population	Percentage range of population covered by an	single choice	Quantitative	Social	Enhancing disaster preparedness for effective response and to	Confrontation with providers; consultation with public sources

covered by an internet connection?	internet connection					build back better in recovery, rehabilitation and reconstruction	
						Strengthening disaster risk governance	
How many hazard education actions have been organised with community engagement during the last 5 years?	Number of hazard education actions organised with community engagement during the last 5 years	no.	Quantitative	Social		Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	Stakeholders' engagement activities (i.e., interviews); reports of the actions/activities.
						Strengthening disaster risk governance	
How many people have been involved in hazard education actions during the last 5 years?	Number of persons involved in hazard education actions during the last 5 years	no.	Quantitative	Social		Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	Stakeholders' engagement activities (i.e., interviews); reports of the actions/activities.
						Strengthening disaster risk governance	
Which types of people categories have been involved in hazard education actions?	Types of people categories have been involved in hazard education actions	multiple choice	Qualitative	Social		Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	Stakeholders' engagement activities (i.e., interviews); reports of the actions/activities.
						Strengthening disaster risk governance	

Are community representatives involved in Integrated System of Civil Protection planning groups?	Involvement of community representatives in Integrated System of Civil Protection planning groups	y/n	Qualitative	Social	Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation and reconstruction	Analysis of plans; stakeholders engagement activities (i.e., interviews)
				Politic	Strengthening disaster risk governance	