



HAL
open science

Rethinking the share of responsibilities in disaster preparedness to encourage individual preparedness for flash floods in urban areas

Charlotte Monteil, Pierre Foulquier, Stéphanie Defossez, Freddy Vinet,
Matthieu Péroche

► To cite this version:

Charlotte Monteil, Pierre Foulquier, Stéphanie Defossez, Freddy Vinet, Matthieu Péroche. Rethinking the share of responsibilities in disaster preparedness to encourage individual preparedness for flash floods in urban areas. *International Journal of Disaster Risk Reduction*, 2022, 67, pp.102663. 10.1016/j.ijdr.2021.102663 . hal-03689559

HAL Id: hal-03689559

<https://hal.science/hal-03689559>

Submitted on 5 Jan 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial 4.0 International License

Rethinking the share of responsibilities in disaster preparedness for encouraging individual preparedness to flash floods in urban area

Authors: Charlotte Monteil, Pierre Foulquier, Stéphanie Defossez, Mathieu Péroche, Freddy Vinet

Abstract:

Reducing the risk of disaster linked to major flash floods implies multi-scale preparedness measures. Sendai framework for disaster risk reduction encourages the involvement of vulnerable people as technical measures are often insufficient to decrease the risk of disaster. Yet, decision-makers often struggle to motivate people to prepare, even in case where the risk of disaster is well known. To address this issue, this article explores how responsibilities for preparedness are shared among stakeholders. We analyze the preparedness process in the Richelieu neighborhood of Nîmes, a flash-flood prone city in the south of France. This neighborhood has been devastated by a major flood in 1988 then by several minor water runoffs. We used a mixed-method approach, based both on a quantitative analysis of a questionnaire conducted in the whole city of Nîmes, and a qualitative analysis of interviews conducted with local stakeholders of Richelieu. We explore the major obstacle for individual willingness to prepare. We highlight multiple forms of marginalization that impede individual willingness despite the recent disasters and the well-known vulnerability of the neighborhood. We argue that there is a mismatch between a centralized top-down DRR approach and the request from local authorities for individual preparedness. We argue the way responsibilities are shared for preparedness has to be transformed through a holistic approach in order to give the capacities to individuals to be willing to prepare to flash floods.

KW: preparedness, flash floods, Nîmes, shared-responsibilities

1. Introduction

The approach to disaster risk reduction (DRR) has been largely questioned since there is still a persistent risk to disasters despite technological improvements in mitigating natural hazards. Sendai Framework for DRR encourages a shift towards a “shared responsibility” approach, hence recognizing people’s abilities to act for their resilience¹. This shift of paradigm requires multiple adaptations at the national scale. It implies a transition from a top-down command-and-control civil defense structure to one that promotes shared responsibility between government, businesses, non-government, communities and individuals, with the objective to enhance people's resilience to disaster.

Individual preparedness is an aspect of adaptation to natural hazards. It is defined by UNISDR (2015) as the knowledge and capacities developed by governments, responses and recovery organizations, communities and individuals to effectively anticipate, respond to and recover from the impacts of likely, imminent or current disasters. Research have highlighted the importance of individual preparedness in facing exceptional flash floods²⁻⁴, especially in case where the level of risk is too high for being addressed through technical measures implemented by authorities. Therefore, this requires some forms of coordination between stakeholders. Yet, at a local scale, decision-makers struggle to promote individual preparedness, even within very vulnerable neighborhoods and despite all the efforts to address these obstacles.

There have been multiple studies questioning the motivators for preparedness and exploring the gaps between experience of disaster, perception and preparedness⁵⁻⁸. It has been widely demonstrated that there is not a clear relationship between risk perception and preparedness and that there are multiple obstacles to preparedness, especially at individual level^{5,9,10}. Using a mixed-

method approach, we analyze the case of Nîmes, a city in the South of France, and more specifically of the neighborhood Richelieu, very exposed to flash floods. We question how official national and local programs affect the share of responsibilities for disaster preparedness and the capacity of individuals, inhabitants mainly, to adopt preparedness solutions. We highlight that the local authorities have mainly focused on a top-down command-and-control approach before starting more recently to encourage individual responsibilities for preparedness as technical solutions were insufficient to face major floods. We analyze whether shared-responsibilities are in accordance with the recommendation of Sendai Framework of DRR and actually reflect a change of paradigm, and how they encourage or impede individual actions for preparedness. We argue that in France, the shift of DRR paradigm has not been translated enough in practice. We argue here that the process of shared responsibility is hindered by the diverse forms of marginalization that are yet to be addressed.

2. Conceptual framework

2.1. A shift of disaster risk reduction paradigm

The Sendai Framework for DRR (2015-2030) was adopted by the UN member states, a more ambitious successor to the Hyogo Framework for Action (2005-2015)¹. It emphasizes that the “capacity of a community to withstand, or adapt and transform in response to disaster events, is not adequately represented by structural determinants of vulnerability alone “. It outlines four priorities for action to prevent new disasters and reduce existing disaster risks, namely: (i) understanding disaster risk; (ii) strengthening disaster risk governance to manage disaster risk; (iii) investing in disaster reduction for resilience and; (iv) enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation and reconstruction. The adoption of this framework marks an important shift from reacting to the impact of disasters to managing and reducing risks that lead to disasters, in other words preventing disasters. It states that the reduction of the frequency and impacts of disaster requires a better understanding of disaster risk and an improvement of risk governance. In fact, researchers and policy decision makers are now looking beyond engineering-based solutions to natural hazards, which includes social and environmental factors that support resilience building ^{11,12}. This involves “building political will and action to ensure that all development programming and future investments are risk-informed”¹³.

At the national French scale, flood-related disaster risk reduction measures have gradually shifted since the beginning of the 21st century, in line with Sendai Framework’s recommendations and European flood directives¹⁴⁻¹⁷. While it was mainly a command-and-control approach, based on physical infrastructures aiming to mitigate hazards¹⁸, DRR preparedness increasingly integrates governance measures, including forecasting, alert systems, land planning and insurance ¹⁹. The aim is to include both technical solutions and social vulnerability reduction measures. The rising awareness of the uncertainties linked to climate change ^{19,20}, and the limits of physical infrastructures, in terms of cost, management and lack of flexibility especially, contributes to accelerate the change of DRR approach.

This shift has been translated in France by the implementation of regulative measures like prevention plan for flood risks (PPRI), communal safety plans (PCS) and action program for flood prevention (PAPI). These tools emerged from the Barnier law in 1995, the civil safety modernization law in 2004 and the white book for defense and national safety published in 2008 by the government. Regulations for land management are driven by PPRI, which delimitates risk zones based on past experiences¹⁵. This is often criticized for being too inflexible and constraining, hence

hard to be accepted by the local population and therefore hard to be implemented. Douvinet et al.²¹ emphasized the lack of technical competencies, financial means and mobilization of stakeholders as main obstacles for the implementation of regulative plans at a local scale. PAPI is more dedicated to vulnerability reduction through actions plans. Yet, in practice, it is largely dominated by a technical approach, combining structural measures and vulnerability reduction measures. Moreover, French DRR approach is criticized for being focused on specific hazards instead of adopting a holistic, systemic approach, integrating interactions between multiple hazards and their associated risks¹⁶.

2.2. Responsibilities-share: collective vs individual responsibilities

Sendai Framework emphasized shared-responsibility as a guiding principle for its four priorities for actions¹. The change of DRR paradigms implies that each segment of society has some forms of obligations in disaster management. This means that stakeholders have to jointly coordinate, plan, or carry out a particular action with a view to achieving a particular outcome. Nollkaemper²² argues that shared responsibilities do not imply the aggregation of individual responsibilities, but instead that each of their responsibilities is “based on multiple actors contributing to each other’s acts” and to the eventual outcome.

Various studies have highlighted that for shared-responsibilities to be possible, it is necessary that governments and disaster management agencies clearly articulate what is expected from each stakeholder, what that implies for everyone and where the gaps are^{22,23}. Coordination can be stated formally or informally²². Atkinson and Curnin²³ emphasize that shared-responsibility involves a specific social contract. Using Foucault’s approach to social contract, Atkinson²³ argues that shared-responsibility is crucial as it links the security and well-being of both individual and collective life. In the Australian context, McLennan and Handmer²⁴ emphasized that shared-responsibilities is a partially articulated social contract, or a metaphor for a renegotiation of roles and responsibilities in disaster management. Yet, they argue that there is a poor emphasis on the benefits and rights that the citizens would receive under this new paradigm. This is in particular due to a failed articulation of goals, rules and roles of each stakeholder. Research highlights how governments promote a “shared responsibility” approach for enhancing disaster resilience, yet, without a clear pathway to achieve it^{12,24}.

Interestingly, scholars have emphasized how poorly coordinated shared-responsibilities could lead to harmful outcomes or side effects²². Nollkaemper²² says that “a system of responsibility that disaggregates responsibility into individual cases of wrongdoing, and that does not connect well to the structure of international cooperation, may undermine key benefits of the law of responsibility. It may hinder answerability for the exercise of public authority, sustain collective action problems, and legitimize harmful practices. Its most visible drawback is that it makes it difficult for persons who suffer injury to figure out who is to blame for the harmful effects”.

In terms of flood-related disaster risk reduction, responsibility-sharing between public and private actors can involve a large range of activities, such as planning objectives and choosing strategies^{25,26}. A central concern is the appropriate division of responsibility for mitigating flood risk before an event and paying for recovery after a flood event. Some countries like Canada have undergone key changes over the last years, with a shift of some of the responsibilities for flood management from governments to property-owners. Yet, Henstra et al.²⁷ question the level of public acceptance of this greater responsibility.

2.3. Preparedness

A central element of the shift of DRR paradigm lies in the need of adapting the way society lives in order to make it less vulnerable and more resilient. This implies learning from past experiences and consecutive adaptations. Adaptiveness is defined as the capacity of a system or actor to adapt to changes in its environment, as a response or in anticipation, with the objective to maintain its essential functions²⁸⁻³⁰. It implies assessing the experience of the disaster and learning from it through deliberate and unconscious strategies among social organizations and processes, at individual or collective level.

As part of these adaptations and in line with the share of responsibilities, the Sendai Framework encourages preparedness to natural hazards and involves knowledge about hazards and risk of disaster, and capabilities to act. Paton (2003) distinguishes both acts, underlining that one does not certify the other, and that additional motivators are needed to support the implementation of actions. It includes in particular storing first needs items, i.e. food and water, securing furniture and essential items, securing electrical facilities, preparing an emergency and evacuation plan.

Many studies have attempted to understand the motivators for individual preparedness, in order to increase the effectiveness of disaster risk management^{6,32-34}. Paton³¹ argues that the importance of understanding the cognitive process underpinning behaviors, i.e. acting for preparedness, instead of focusing on antecedents of behaviors. He suggests that once individuals are motivated to think about hazards, their motivation to initiate actions for preparedness, and then the decision to actually act, depend on other factors. It is therefore necessary to consider preparedness as a multi-step process, and act on their associated factors. Similarly, several studies suggest to consider critical awareness and hazard anxiety in addition to risk perception in order to understand what motivates protective behaviors³³⁻³⁶.

Many studies have shown the multi-factorial dimensions of the decision to act, including the outcome expectancy and self-efficacy perception^{31,37-39}. Importantly, Wachinger et al.⁴⁰ highlighted that there is no straight link between experience of a disaster, risk perception and preparedness, unlike what is often assumed⁹. Grothmann and Reusswig⁴¹ emphasizes that communicating on the risk of flooding is not enough if there is not also communication about the possibility, effectiveness and cost of private precautionary measures. Paton⁴² suggests that the intention of acting may be translated into actual preparation depending especially on the sense of community, the type of social capital, the degree of sense of personal responsibility for their safety, and the anticipated timing between two events.

The importance of social capital for development and resilience is now widely acknowledged, in particular for reducing the risk of disaster⁴³⁻⁴⁸. A few studies suggest that social norms play a major role on preparedness⁴⁹⁻⁵⁵. McIvor and Paton⁵⁶ and Morrisson et al.⁵⁷ show that people involved in a social network that support preparedness may be more favorable to preparedness and less prone to fatalism. Paton⁴² suggests that intention of actions may be moderated by normative beliefs within a community, such as the collective perceptions and beliefs built through people's interactions. In particular, Paton and Bishop⁵⁸ underline the impacts of the relationship between resilience to adversity and social justice, with in particular the importance of trust in the authorities^{9,59}, participation and empowerment^{36,60,61}.

A key component of DRR is how scientific experts and local authorities sensitize vulnerable people to the risk and encourage them to adopt protective measures. Research shows that awareness and motivation to initiate preparedness measures are largely linked to people's involvement in participatory exercises. It contributes to promote trust in the authorities and experts, a better understanding of personal agency for preparing to hazards, and it avoids creating a false

sense of safety. Research have argued that a major reason of the lack of preparedness action is not the level of information people have about risk, but how they interpret it in their specific context of experiences, beliefs and expectations^{62,63}. Paton ⁶⁰ argues that this is partly linked to the relationship between the community and the source of information, rather than the type of information given. Johnson-George and Swap ⁶⁴ and Sjöberg ⁶⁵, and Siegrist & Cvetkovich ⁴⁸ emphasized that importance of trust about a source of information grows with the level of uncertainty of a situation people face. Paton ³¹ argues that “trust functions to reduce the uncertainty and complexity that people encounter when faced with novel events”. In particular, it influences how are perceived the motives, competency and credibility of those providing the information, often the scientists and authorities ⁶⁶. This is therefore particularly important in context of uncertainty linked to the occurrence and intensity of natural hazards. Trust contributes to determine, in particular, the share of tasks and responsibility, and the level of involvement of each actor within the efforts of DRR and preparedness. Yet, high levels of trust can be counterproductive as people may lose the sense of personal responsibility and fully rely on authorities^{67–69}.

3. Methodology

3.1. Case-study: Nîmes and Richelieu

This research was conducted in Nîmes, a city in the South of France, on the south-east of Massif Central range of mountains, with a special focus on the neighborhood of Richelieu. Nîmes is located at the confluence of six Mediterranean intermittent rivers, wadis type, locally called “cadereaux”, that are channeled under the city (Figure 1). The latter are often flooded in Autumn when storm cells are carried over the Mediterranean Sea by southern air flows ⁷⁰. Nîmes has experienced some major floods, especially in October 1988 due to intense and prolonged rainfalls on an already waterlogged soil. Eleven people were killed as water rose up to more than three meters in some places, intensified by the narrowness of the streets and urban logjams. The whole city was affected but the Richelieu neighborhood experienced the most devastations due to its location on one of the most flooded rivers, the Uzès Cadereau. The neighborhood has faced several other minor floods since 1988, mainly caused by local urban runoff.

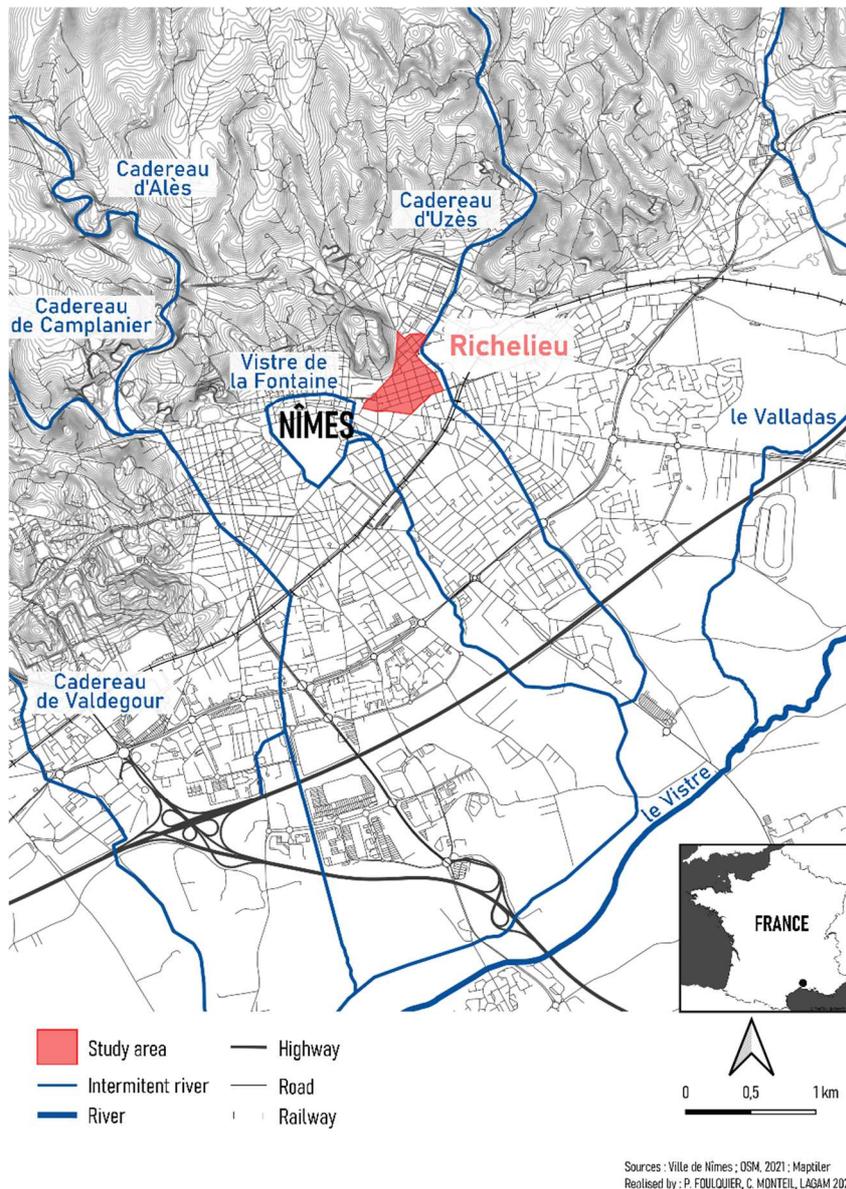


Figure 1: location of the study area and rivers

The 1988 flood has triggered a rise of awareness at French scale about flood management and DRR measures. In Nîmes, the local authorities have started expensive structural works in order to mitigate flood hazards. This includes works for enlarging the channels and the creation of retention ponds, that are explicitly designed for coping with minor floods. Gradually, local authorities have encouraged a shift toward a more holistic approach that includes collective and individual preparedness measures, following European and international recommendations and based on the principle that no structural measures can be sufficient for coping with a flood like the 1988 one.

The Richelieu neighborhood is particularly vulnerable to flash floods because of its location and because of its socio-demographic structure. It is a sub-central neighborhood, built in 1750 for the railway workers organized around an orthogonal grid of roads and shared courtyards between single to three-story houses ^{71,72}. Like many sub-central neighborhoods in France, it is gradually deteriorating and impoverishing, partly due to the disinterest of urban policies. Its structure has changed, with houses being divided into flats and internal courtyards divided and closed down by doors and electronic locks. Its dense structure makes evacuation and relief access difficult and it

facilitates the creation of vehicle logjams. It also restricts meetings between the different social groups.

In 2021, it officially hosts 2640 houses and 4125 inhabitants⁷². It also hosts an unknown but not negligible number of illegal occupants. In 2021, its population was very heterogeneous, with both landlords and tenants. 15% of its population is immigrant. 30% of its population was unemployed in 2010⁷³. The 1988 flood has accelerated the deterioration and demographic transformation of the neighborhood as a large number of houses have been abandoned and/or transformed by property developers. It faces a rapid turnover of its population, affecting the capacity to create a strong bonding network and identity within the neighborhood. Since then, it suffers from high levels of degradations and insalubrity. Since 2018 and until 2023, it is involved in a program of improvement of the quality of the housing (OPAH-RU).

Nîmes, and more specifically Richelieu, have been chosen as case-study because of their high vulnerability to flash-flood. Because this research is part of the bigger inter-disciplinary DEUFI (Detailed Urban Flood Impact) project, there was already a large set of data made available, including flood models provided by the hydrologist team member of the project, and socio-demographic data provided by the city of Nîmes. The aim of the research was to understand how responsibilities for preparedness are distributed within a neighborhood that is well-known for being highly exposed and vulnerable to flash floods.

3.2. Methods

The research is based on a mixed-method approach, with two main sets of data. On one hand, quantitative data were provided by the city of Nîmes. They were collected with 1600 individuals in all Nîmes, including 60 in Richelieu. They were initially collected for a vulnerability diagnosis, as part of the Nîm'alabri program. They include socio-demographic variables, physical variables about houses (electricity, shelter story, doors...), information about preparedness, experience of flood and perception of flood. Not all data were exploitable because they were not collected for a research purpose. Data was analysis mainly through descriptive statistical analysis using SPSS. A general linear model was also done on SPSS in order to understand what variables influences the most the answer to the question "do you feel concerned by the risk of flood".

A qualitative method was also used to understand the motivations leading individual behaviors and preparedness, and to understand how risk is perceived. Because of successive restrictions due to covid crisis, the short time available for this study and the social structure of the neighborhood, it was impossible to meet a large range of inhabitants. Therefore, it was decided to meet only key actors of the Richelieu neighborhood who could have an overview on socio-demographic conditions and evolution of the motivations. In-depth semi-structured interviews were conducted, with record and/or detailed note-taking, with each of them during thirty minutes to 1hour30, with:

- A seventy years old couple, landowner, who experienced the 1988 flood and the next ones. They are involved in the associative life of the neighborhood
- A real-estate agent, settled in the neighborhood for several decades and who also experienced the 1988 floods
- A social worker, who lives in the neighborhood, as tenant, and who works with marginalized inhabitants of Richelieu

- An employee of a consulting firm in charge of vulnerability diagnosis for the local municipality
- A woman living out of the neighborhood but involved for long time in associative life that included Richelieu (interviewed by phone)

Notes were also taken for the purpose of this study during meetings with the consulting firm and local authorities. The interviews were anonymized. All data, including notes and audio records, were transcribed and coded in NVivo for triangulation and analysis, based on a thematic coding.

4. Results

4.1. Preparedness

Due to its socio-demographic structure, physical characteristics and location, Richelieu is particularly vulnerable to flash-floods related disasters. The 1988 flood has highlighted first the need for mitigating the hazard, then the need for increasing collective and individual preparedness.

4.1.1. Collective preparedness

Collective preparedness measures have been driven by several local and national plans. We analyze here how the recommendations have evolved through time and with Sendai framework and European recommendations (Table 1).

Table 1: Main local and national plans, driving flood risk preparedness measures in Nîmes

Name of the program	Period of action	Main objectives	Scale of action	Main actors	Main changes
Program	Period	Main objectives	Scale of action	Main stakeholders	Main changes
Protection Program against Flood (PPCI)	1990-2006	<ul style="list-style-type: none"> ♦ Involves mainly hydraulic work ♦ Management of water channel within the city, water containment and management of surface runoff, upstream and downstream from Nîmes ♦ Since 2004, initiates the alert system ESPADA (Modelling tool for real time management of urban flash flood, for improving alert system) as part of the alert and forecasting work package (Pla et al., 2009) 	Nîmes	Local authorities of Nîmes French government, Region and Department (for funding).	Plan mainly focused on mitigating hazards. Although it mentions a vulnerability reduction goal, it does not explicitly specify the means to reach this objective. It is criticized for being very top-down ⁷⁵ .
PAPI I (Program for Action and Prevention of Floods)	2007-2014	<ul style="list-style-type: none"> ♦ Officially aims at a more holistic approach for reducing the risk of flood at the catchment scale for reducing impacts on human life, goods, economy. ♦ Involves (1) improvement of risk knowledge and awareness, (2) flood forecasting and monitoring, (3) alert and crisis management, (4) urban plans for flood risk, (5) people and goods vulnerability reduction, (6) efflux control, (7) management of flood protection structures. ♦ Presented by the city council as “important technical preventive work to avoid disaster” ♦ Vulnerability reduction actions through identification of vulnerable houses within riverbed 	Multi-scale (from city to catchment scale)	multi-actors	This plan starts considering the issues of social vulnerability and adopts a more holistic approach. It is criticized because of a poor coordination between actors and scale ⁷⁶ . It is still a top-down plan, with no integration of inhabitants and unclear measures for vulnerability reduction

PCS (Communal safety plan)	2008	<ul style="list-style-type: none"> ♦ Operational plan for determining missions, immediate measures in case of crisis, alert, safety rules, defined at local scale ♦ It is decided by local authorities and implies regular information to inhabitants, political and economic stakeholders ♦ It can imply the creation of a citizen group for getting involved in disaster management 	Nîmes	Local authorities of Nîmes	It explicitly takes into consideration the human dimension of risk. Yet, it is unclear how it involves the local population.
PPRI (Prevention Plan for flood risk)	2012	<ul style="list-style-type: none"> ♦ Cartographic and regulative tool defining risk zones and regulating buildable areas depending of reference floods 	Nîmes	National authorities	
PAPI II	2015-2021	<ul style="list-style-type: none"> ♦ Following part of PAPI I, with a greater focus on risk awareness and risk education, diagnosis vulnerability of houses, improvement of ESPADA (alert and forecasting system) ♦ Improvement of channels to increase efflux capacity 	Multi-scale (from city to catchment scale)	multi-actors	There is a greater and more explicit focus on social vulnerability. Yet, it remains a top-down plan and it is unclear how the population is involved within the project, other than through house vulnerability diagnosis.

There has been a gradual shift from programs that were entirely focused on structural approaches, based on the command-and-control paradigm, to programs that gradually take into consideration the need to adapt and prepare. Yet, this has mainly been translated by urban planning, with unclear and very limited measures for actually addressing vulnerability issues. The local authorities indeed explicitly admit that the structural measures, including retention pond and enlargement of underground channel, cannot be sufficient for floods like the 1988 one. These maps, made by the city of Nîmes (Figure 2) show that in 2013, the type of structural adaptations that have been done, does not mitigate the risk for major floods like the 1988 one, but should prevent minor floods like the 2005 one.

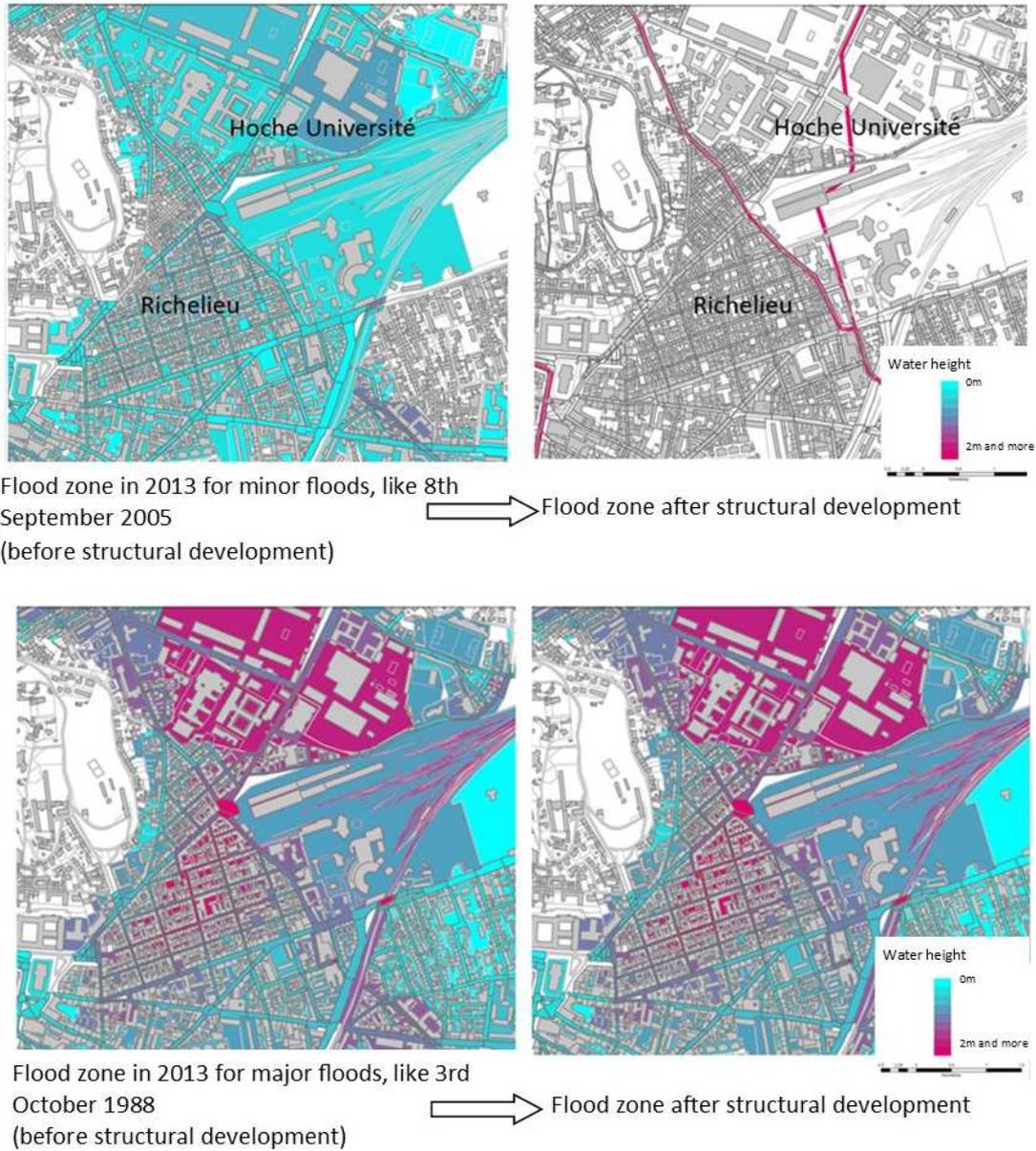


Figure 3: evolution of the flood zones before and after structural development, for minor (above) and major (below) floods. Provided by the city of Nîmes

Both practitioners and academics recognize the need for additional measures, in particular individual preparedness. In a press release, the mayor of Nîmes states “Completed or future developments of the river channel will limit the consequences of important rainfalls, like the ones of

September 2005. But they will not be sufficient in containing torrential runoff caused by centennial rainfalls or rarer rainfalls like the ones of the 3rd October 1988. Based on that, the population has to be aware about the type of risk in order to adopt the best behavior to face this danger. To this end, the city will display floods marks. [...] they encourage the population to stay prudent by being actor of their own safety” ⁷⁷. Hence, for major floods, decision-makers attributes the responsibility for preparedness to individuals, while they consider structural top-down approach sufficient for minor floods.

4.1.2. Individual measures for DRR

4.1.2.1. Top-down recommendations for individual preparedness

Local authorities now aim to reduce social vulnerability to major floods through individual preparedness. Therefore, they emphasize the need of reinforcing individual responsibilities. On the website noe.gard.fr, which is dedicated to flood information in Nîmes, it specifies: “To face this threat, everybody is responsible. Landowners, tenants, parents, educators, association members..., everybody is an agent of their own security. Everybody may be concerned, without necessarily living directly nearby a river. If that is not through their accommodation, it may be by their workplace or by their children’s school”. Yet, recommended measures are not compulsory because of legal provisions, hence their implementation depends on individual willingness and capacities. Interviews with key stakeholders involved in the neighborhood have underlined a noticeable gap between recommendations and implementations.

The official website noe.gard.fr specifies how individuals can act for their own responsibilities. It emphasizes the need for getting informed and risk aware. In terms of anticipation, it highlights the preparation of a safety kit to face power cuts and waiting time before the arrival of relief, and the preparation of a familial plan for safety procedure. It also emphasizes the individual responsibility to keep informed about risks and to request a vulnerability diagnosis of home and adapt the house. It advises to check two major documents, namely the DICRIM and PCS (yet, in practice not always available for public consultation), to identify safe places and evacuation paths in case of flood, check meteorological forecasts, to save important papers and to make a list of useful contacts. Yet, they do not promote people’s involvement within DRR measures, other than the respect of top-down recommendations.

Moreover, it addresses the need of reducing vulnerability through three main approaches, that are (i) the development of a risk culture, through flood landmarks and a permanent exhibition on floods in Nîmes, (ii) land use planning, (iii) vulnerability reduction, focusing on goods and housings, and adaptation of houses when necessary. This last aspect is the most detailed on all informative documents. In the Richelieu neighborhood, it refers to the transformation of ground-floor apartments with no access upstairs into duplex apartments, the setup of cofferdams or check valves after a housing diagnostic. However, except for these recommendations, other measures for reducing vulnerability and developing risk culture are poorly detailed and do not address the issues that prevent people from informing themselves and/or preparing themselves and their houses. Despite a diagnosis that also includes some social questions, explicit recommendations for preparedness only focus on physical, technical work.

4.1.2.2. Who intends to act?

As Paton (2003) underlines, preparedness starts by motivation and action plan. We analyzed one aspect of it, the expressed intention to act.

In Nîmes, we have found that less than half of the population, or 44.6% of the 1660 questioned households for the vulnerability diagnosis commissioned by the city, declare that they want to do some work to prepare their house, and about 19% are unsure. We notice that among the 710 households who are willing to do work in their house, 15 actually explain in a more detailed answer that there are obstacles for them to do this work, and 152 are not definitive about it and wait for the diagnosis. This means that only 33% of the whole sampled population actually expect to do some work in their house.

Interviews of local stakeholders involved in the physical adaptations of the houses in the neighborhood of Richelieu underline the challenges for implementing these changes. During her interview, an employee of the consulting firm in charge of housing diagnostic explains that after the diagnosis, requested on a voluntary basis, not all residents decide to do the work. The recommendations of work are nevertheless one of the main individual preparedness measures that people could adopt.

4.2. Determinants of willingness to adapt

Research on individual preparedness have shown that the decision to act is dependent on multiple interdependent factors, including trust in local authorities, knowledge and perception of risk or sense of efficiency^{6,31}.

4.2.1. Factors favorizing concern about risks of flood

As not all vulnerable households are worried because of the risk of flood, we have attempted to identify the main factors that have influenced the answer to the question “do you feel concerned about the risk of flood” the most. This question is one of those asked in the questionnaire commissioned by the city of Nîmes for vulnerability diagnosis. Although this question does not specifically inform about risk perception, it informs about one dimension of it, the worry⁷⁸.

A logistic regression was calculated to predict the level of concern about floods based on the variables (1) experience of the 1988 flood, (2) experience of the 2002 flood, (3) experience of the 2005 flood, (4) experience of the 2014 flood, (5) total number of floods they have experienced, (6) total number of minor floods that people have experienced (other than 1988 one), (7) number of dependent people, (8) dwelling floor, (9) level of isolation, (10) intention to do preparedness work to face floods.

From the analysis, only the variable *envisagetravaux* (7) (intention to do preparedness work) and those who experienced the 1988, 2002, 2005 and 2014 floods significantly add to the logit model (p -value < 0.05). The model explained 15% (Nagelkerke R^2) of the variance in the level of concern and correctly classified 65% of those who feel concerned by the flood risk. Data shows that *envisagetravaux*(7) (intention to do preparedness work) is 2.5 times more likely to be concerned with floods. Apart from that, the regression also indicated that those who experienced the 2005 flood are 8.9 times more likely to be concerned with future floods while those who experienced the 2002 or 2014 floods are both only about 4 times more likely to be concerned with floods. Interestingly, those who experienced the much severe 1988 floods are less likely to be concerned with floods compared to those who experienced the more recent ones, as they are only 1.7 times more likely to express concern. Data shows the fact that they have experienced several floods during their life and the fact that their house is actually vulnerable makes them more concerned about floods. Demographic variables do not have a noticeable impact on the model.

4.2.2. Main obstacles

Among the 1600 households sampled in the questionnaire commissioned by the city of Nîmes, the reasons for not being willing to start work for physical preparedness to flash floods were very diverse and coded as the categories below (Figure 3):

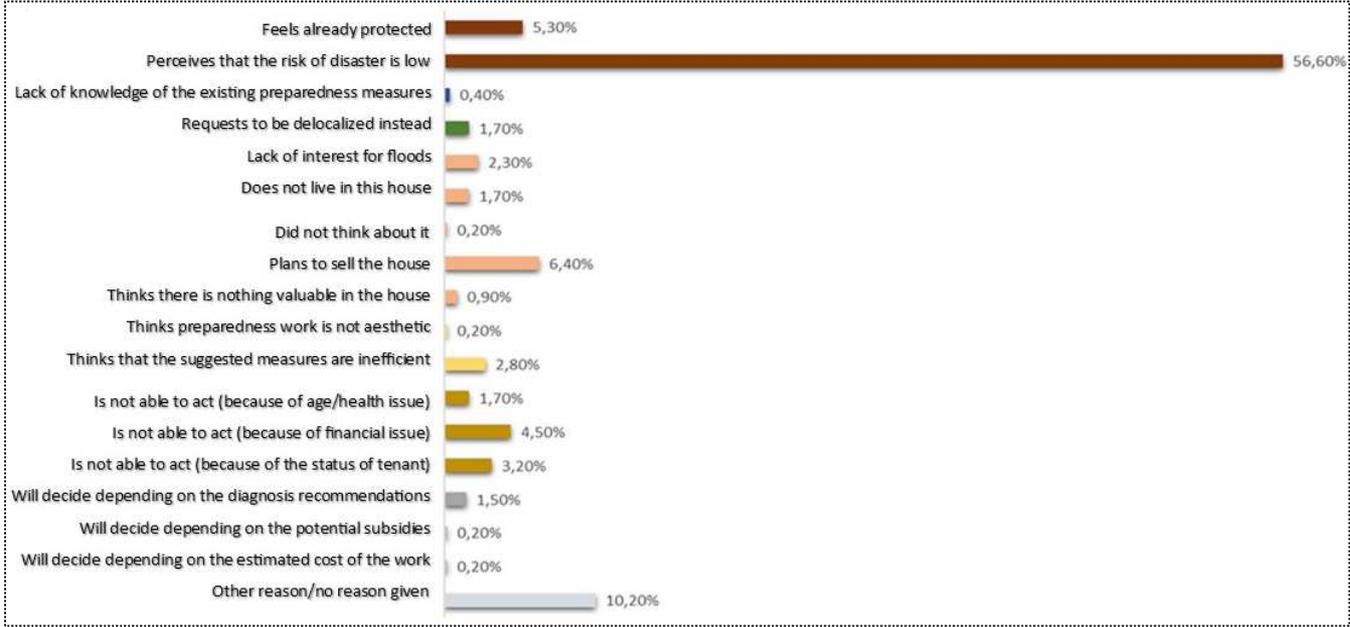


Figure 4: main raisons given by sampled people during the vulnerability diagnosis to justify why they do not intend to act

Our study confirms that there are multiple justifications for not intending to prepare for risks in a very-prone disaster area. The main reason is the perception that the level of risk is low. Respondents say for instance that “they do not feel concerned by the risk”, that “their house has never been flooded” or “that the risk is too exceptional for taking action”.

By analyzing the interviews conducted in the Richelieu neighborhood, we are able to get a better understanding of some of the main obstacles to individual preparedness, namely conflicting priorities, limited capacities to act, limited sense of efficiency, the oblivion of the disaster and sense of safety.

- Conflicting priorities

According to the interviews conducted with local stakeholders, one of the main considerations was the fact that floods were no longer a priority both for the residents and for the local development agencies. Two main aspects were underlined. On one hand, there is the fact that the last major flood was in 1988 and since then, a lot of work has been done in the city, considerably changing the type of hazard. Preparing houses and people in case of flood therefore seems to be a very long-term concern, for a hazard that could not occur in the same way anymore. Interviewees underline the exceptional character of floods. They explained that the 1988 flood occurred because of an exceptional combination of factors and that floods similar to the 2005 one are supposed to be mitigated by the newly built infrastructures.

On the other hand, the preparedness measures for mitigating the impacts of floods compete with the crucial and urgent works that has to be done for improving the sanitation level of houses and reducing insalubrity in the neighborhood. When they are asked about the work to do in the neighborhood, the interviewed social workers and inhabitants first highlight the issues of cleanliness, safety, lack of car parks etc. The issue of flood preparedness only emerges during the interview when mentioned by the researcher. Similarly, an urban planner explains that after recommendations are

given, owners often decide to focus only on the main ones, related to sanitation, because only those are compulsory and because it is too constraining to multiply the work, for sanitation purpose and for flood preparedness. Moreover, interviewed people underline that by choosing not to do preparedness work, owners think they save money. For instance, converting two distinct flats into a duplex to allow an access upstairs means that owners accept to have only one rent instead of two. They regret the lack of sufficient financial subsidies to encourage them to this choice. Several stakeholders explained during interviews that a large number of buildings in the neighborhood were rented by slum landlords, in order to maximize profits, and therefore with no interest for sanitation or safety. A real estate agent said in march 2021: "it is because investors are investors [that there is no change]. They don't try to work for patrimonial interest, they try to make profit". Another local stakeholder said in march 2021: "There have been many garages that were transformed into flat. [...] You don't have to ask anything to anyone and you can do whatever you want. [...] I think the rules are quite permissive". Although this is publicly well known, there is no legal procedure to enforce those landlords to adapt their property to flood, aside from the compulsory measures.

- Limited capacities for acting due to age, health or financial capacities

Another major obstacle, expressed 9.4% by respondents of the survey who do not want to start preparedness measures, refers to the limited capacities to implement preparedness work. This includes lack of capacities related to health and age; financial issues and the fact of not being owner of the accommodation. During an informal interview, an inhabitant explained that cofferdams were too heavy to carry. It is also important to consider that 62% of the households of the neighborhood are made of one single person according to INSEE (2006), and therefore with limited abilities to start important work. Some of the answers reported in the diagnosis were for instance "Mr. and Mrs. X are worried about the cost and duration of the work to be carried out"; "Mr. X. does not want to spend superfluous money", or "Mrs. X feels too old to carry this work".

On the other hand, the high level of poverty in the neighborhood is a major obstacle. An interviewed urban planning agent explains that the residents living in the most vulnerable housings are generally tenants in very precarious conditions, with no ability to start work on their own and very little power on their landlords, sometimes because they do not have regular contract or regular resident permit. An inhabitant explained in march 2021:

"Housing is very degraded and there is a huge turn-over of people who live there and who have a feeling of relegation"

To justify why it is hard to motivate action in the neighborhood, another inhabitant said:

"I think it is very difficult to mobilize the neighborhood population. If you consider the owner-occupants, everyone stays in their garden. [...] Then you have the ones like me who live there for a long time. [...] among them, there are maybe people who want to act somehow but there is nothing to bring us together. And finally, there is all the population who only is in transit [...] People who live here for a few months and then leave. [...] there has been a lot of attempts to act but it does not succeed".

Although these obstacles are known by decision-makers, as confirmed by the employee of the consulting firm, these do not trigger any additional actions. This same employee explained that the vulnerability diagnosis is not requested by those who are not able to act, and that there is no action plan to conduct the diagnostic for the whole population and extend the actions. There is therefore a form of fatalism about the social vulnerability of the neighborhood, from both decision-makers and residents.

- Limited sense of efficiency in regards to the potential disaster

Another major obstacle to individual preparedness that emerges from interviews and questionnaires is the limited sense of usefulness and efficiency of the recommended actions. As explained earlier, there is a general sense that the level of risk has considerably changed with the mitigation measures implemented in the city and that there is a low probability of flash flood like the 1988 one. This considerably alters how the risk is perceived, by creating a certain sense of safety, and therefore by leading to the feeling that preparedness work is useless. For instance, an inhabitant said: “It was very exceptional in 88 though. At the meteorological level first, but it was also particular because of the way the city was done. Nowadays, we have the retention basin at least”. A real-estate agent said “we explain the document about natural risks to the future tenant but not so much. We are not going to scare the life out of him. Because, in my view, there is no longer any need”.

Moreover, the 1988 flood is considered as exceptional and impossible to cope with. A former resident of the neighborhood explained that the only solution is to not live on the ground floor. Traumatized by the disaster, she has decided to definitely leave the neighborhood. Another interviewed inhabitant explained that the only solutions are to check the weather and move the cars to a safe place. She does not believe that a cofferdam can have any effect on a flood like the 1988 one and has therefore decided not to set one up. A social worker underlined that a lot of issues were out of control: “you imagine living in a street where the houses next to yours are rotting. Because they are still housing that have been very strongly affected by the 1988 flood”. There is therefore some sense of fatalism regarding the actions to implement for coping with a major flood, both from decision-makers and from residents.

- Forgetting of the disaster

Although the city is well known to be exposed to flash flood, the time elapsing since the last major flood, the infrastructures built for mitigating the hazard and the turn-over of the population contributes to minimize how risk is perceived. It limits the persistence of disaster memory and hence how experience of past disasters could encourage preparedness. According to the vulnerability diagnosis commissioned by the city, only 17% of the inhabitants of Richelieu have experienced the 1988 flood. During an interview, a real-estate agent explained that while ten years ago, new tenants initially asked about the risk of disaster, those questions are now extremely rare. Another inhabitant said:

“1988... there must not be many inhabitants that were here in 1988. [...] the first reason I can think about, it is the housing condition. Because the housing is extremely degraded, and there is a high turn-over of people [...] it comes from the substandard housings, and this obsolescence itself comes from the floods. [...] the last major flood was seventeen years ago. And within seventeen years, the neighborhood population is very moving. And the memory, I don't think the population has it much”.

We also asked residents what were the opportunities to discuss and hear about the past events. They said that this is now a very rare subject of discussion. They did not seem aware of ceremonies for the anniversary of the 1988 disaster. A long-term resident who experienced the 1988 flood said that most of her new neighbors have no knowledge about the 1988 flood and would not believe that the water went up to three meters. Although there are flood marks on the walls as reminders, she does not think people actually see them or even know what they represent.

These obstacles strongly limit the possibilities to increase individual preparedness, despite its importance to complete collective structural measures. It questions the way responsibilities for

preparedness are shared, both through social contract and through the means that are given for individuals to exert their responsibilities.

5. Discussion: Allocation of individual responsibilities

The obstacles for preparedness that were reported in the vulnerable neighborhood of Richelieu coincide with what has been reported in other places through the literature^{6,31,38,79}. We underlined major forms of marginalization that impede the capacity of people to prepare and get informed as the authorities suggest. They include: (i) economic marginalization, with about 45% of the population of the neighborhood living under the poverty line, (ii) social and political marginalization of the whole neighborhood, considered as a forgotten area, with no common place to meet and a part of the population even being irregular.

Nîmes, like the rest of France, depends on a very centralized and hierarchical disaster management approach^{79,80}. In this system, the role of residents is limited to a few aspects only, in particular houses adaptation, for preparedness to major floods mainly. There is therefore a general understanding that responsibility for DRR is allocated to decision-makers mainly. Individual preparedness measures are currently occasionally required, within a process that is mainly top-down and hazard-centered. Authorities encourage individual responsibilities only when collective technical measures can no longer reduce the risk of disaster efficiently. The responsibility-share shifts depending on the intensity of the event, with a greater responsibility allocation to individuals when technical measures become insufficient regarding the type of hazard. Moreover, we highlighted how local authorities consider that it is the responsibility of people to get informed. Yet, the communication actions are undermined by the rapid turn-over of the population and the demographic heterogeneity. There is also the assumption that it is the responsibility of residents to show solidarity and support before, during and after the flood, and that it is the responsibility of people to adopt protective measures (cofferdams, moving cars to safe places, adapt their accommodation), with the support of the authorities. Yet, it is unclear how actions are done to make it possible to exert individual responsibilities through the existing programs.

Although individual responsibilities are claimed to be a crucial factor for reducing the risk of disaster, they are requested without initial involvement of the population within the decision-making process. These paradoxes and the failure to stimulate individual responsibilities therefore highlight that the shift of paradigm for DRR, as recommended by Sendai Framework for DRR, has not been achieved in Nîmes. The recommendations for individual preparedness measures mismatch the general sense of marginalization of the neighborhood and mismatch the general top-down approach that is promoted for minor hazards. It reveals several non-addressed obstacles for promoting the shift from motivation to act to actual action, according to Paton's model³¹. Here we argue that allocating individual responsibilities for disaster preparedness and facilitating the shift of DRR paradigm cannot be done without addressing the factors of individual and collective marginalization, through a holistic approach and actions conducted at the collective level. It is therefore crucial to reconsider both the way responsibilities are shared between DRR agencies, local authorities and residents, in term of social contract⁸¹ and individual capacities to act, and to involve the residents within the decision-making process.

Acknowledgments: This work has been supported by the French National Research Agency (ANR) under the grant ANR-18-CE01-0020. We also express our gratitude to the municipality of Nîmes for providing data.

1. United Nations Office for Disaster Risk Reduction. *Sendai Framework for Disaster Risk Reduction 2015 - 2030*. (2015).
2. Kreibich, H., Thieken, A. H., Petrow, T., Müller, M. & Merz, B. *Natural Hazards and Earth System Sciences Flood loss reduction of private households due to building precautionary measures-lessons learned from the Elbe flood in August 2002*. *Natural Hazards and Earth System Sciences* vol. 5 (2005).
3. Botzen, W. J. W., Kunreuther, H., Czajkowski, J. & Moel, H. Adoption of Individual Flood Damage Mitigation Measures in New York City: An Extension of Protection Motivation Theory. *Risk Analysis* **39**, 2143–2159 (2019).
4. Poussin, J. K., Botzen, W. J. W. & Aerts, J. C. J. H. Factors of influence on flood damage mitigation behaviour by households. *Environmental Science and Policy* **40**, 69–77 (2014).
5. Wachinger, G. & Renn, O. Risk perception and natural hazards. *CapHaz-Net WP3 Report, DIALOGIK Non-Profit Institute for Communication and Cooperative Research* 1–111 (2010).
6. Staube-Delgado, R. & Kruke, B. I. Preparedness: Unpacking and clarifying the concept. *Journal of Contingencies and Crisis Management* **26**, 212–224 (2018).
7. Paton, D. *Disaster Prevention and Management*. vol. 12 (2003).
8. Weiss, K., Colbeau-Justin, L. & Marchand, D. *Entre connaissance, mémoire et oublis : représentations de l'environnement et réactions face à une catastrophe naturelle*. (2005).
9. Wachinger, G., Renn, O., Begg, C. & Kuhlicke, C. The risk perception paradox-implications for governance and communication of natural hazards. *Risk Analysis* **33**, 1049–1065 (2013).
10. Scolobig, A., de Marchi, B. & Borga, M. The missing link between flood risk awareness and preparedness: findings from case studies in Alpine Region. *Natural Hazards* **63**, 499–520 (2012).
11. Djalante, R., Holley, C., Thomalla, F. & Carnegie, M. Pathways for adaptive and integrated disaster resilience. *Natural Hazards* **69**, 2105–2135 (2013).
12. Singh-Peterson, L., Salmon, P., Baldwin, C. & Goode, N. Deconstructing the concept of shared responsibility for disaster resilience: a Sunshine Coast case study, Australia. *Natural Hazards* **79**, 755–774 (2015).
13. Mizutori, M. Reflections on the Sendai Framework for Disaster Risk Reduction: Five Years Since Its Adoption. *International Journal of Disaster Risk Science* vol. 11 147–151 (2020).
14. Reghezza-Zitt, M. Territorialiser ou ne pas territorialiser le risque et l'incertitude. *L'Espace Politique* (2015) doi:10.4000/espacepolitique.3543.
15. Meschinet de Richemond, N. & Reghezza, M. La gestion du risque en France: Contre ou avec le territoire? *Annales de Géographie* **119**, 248–267 (2010).
16. Touili, N. *et al.* Public perception of engineering-based coastal flooding and erosion risk mitigation options: Lessons from three European coastal settings. *Coastal Engineering* **87**, 205–209 (2014).
17. Terrin, J.-J. *Villes inondables : prévention, adaptation, résilience*. (Parenthèses, 2014).

18. Veyret, Y. & Reghezza, M. Vulnérabilité et risques. L'approche récente de la vulnérabilité. *Responsabilité & Environnement* 9–14 moz-extension://3afb7de8-c846-4987-b533-77ab86e4ed45/enhanced-reader.html?openApp&pdf=http%3A%2F%2Fannales.com%2Fre%2F2006%2Fre43%2FVeyret.pdf (2006).
19. Vanderlinden, J. P. *et al.* Nonstructural Approaches to Coastal Risk Mitigations. in *Coastal Risk Management in a Changing Climate* 237–274 (Elsevier Inc., 2014). doi:10.1016/B978-0-12-397310-8.00005-1.
20. Touili, N. Portfolio d'options pour le renforcement de la résilience : application de principes systémiques de résilience à la gestion des risques d'inondation en Gironde. *Vertigo* (2015) doi:10.4000/vertigo.16671.
21. Douvinet, J. *et al.* L'information sur les risques majeurs à l'échelle communale. *CyberGeo* **2013**, (2013).
22. Nollkaemper, A. The duality of shared responsibility. *Contemporary Politics* **24**, 524–544 (2018).
23. Atkinson, C. & Curnin, S. Sharing responsibility in disaster management policy. *Progress in Disaster Science* **7**, (2020).
24. McLennan, B. J. & Handmer, J. Reframing responsibility-sharing for bushfire risk management in Australia after Black Saturday. *Environmental Hazards* **11**, 1–15 (2012).
25. Sayers, P. *The effectiveness of flood management. A case study of England Prepared by World Meteorological Organization Associated Programme on Flood Management.* www.sayersandpartners.co.uk (2013).
26. Mees, H. L. P., Driessen, P. P. J. & Runhaar, H. A. C. Legitimate adaptive flood risk governance beyond the dikes: The cases of Hamburg, Helsinki and Rotterdam. *Regional Environmental Change* **14**, 671–682 (2014).
27. Henstra, D., Thistlethwaite, J., Brown, C. & Scott, D. Flood risk management and shared responsibility: Exploring Canadian public attitudes and expectations. *Journal of Flood Risk Management* **12**, (2019).
28. Lebel, L., Grothmann, T. & Siebenhüner, B. The role of social learning in adaptiveness: insights from water management. *International Environmental Agreements: Politics, Law and Economics* **10**, 333–353 (2010).
29. Holling, C. S. Understanding the Complexity of Economic, Ecological, and Social Systems. *Ecosystems* **18**, 390–405 (2001).
30. Walker, B., Holling, C. S., Carpenter, S. R. & Kinzig, A. Resilience, adaptability and transformability in social-ecological systems. *Ecology and Society* **9**, (2004).
31. Paton, D. Disaster preparedness: a social-cognitive perspective. *Disaster Prevention and Management* **12**, (2003).
32. Bustillos Ardaya, A., Evers, M. & Ribbe, L. What influences disaster risk perception? Intervention measures, flood and landslide risk perception of the population living in flood

- risk areas in Rio de Janeiro state, Brazil. *International Journal of Disaster Risk Reduction* **25**, 227–237 (2017).
33. Dash, N. & Gladwin, H. *Evacuation decision-making and behavioral responses: individual and household*. (2005).
 34. Lechowska, E. What determines flood risk perception? A review of factors of flood risk perception and relations between its basic elements. *Natural Hazards* **94**, 1341–1366 (2018).
 35. Lindell, M. K. & Whitney, D. J. Correlates of household seismic hazard adjustment adoption. *Risk Analysis* **20**, 13–26 (2000).
 36. Dalton, J. H., Elias, M. J. & Wandersman, A. *Community Psychology: Linking Individuals and Communities*. (2007).
 37. Abraham, C., Sheeran, P. & Johnston, M. From health beliefs to self-regulation: Theoretical advances in the psychology of action control. *Psychology and Health* **13**, 569–591 (1998).
 38. Mishra, S. & Mazumdar, S. Psychology of disaster preparedness. *Ecopsychology* **7**, 211–223 (2015).
 39. Bandura, A. Exercise of personal agency through the self-efficacy mechanism. in *Self-efficacy: Thought control of actions* (ed. Schwarzer, R.) 3–38 (Hemisphere Publishing Corp., 1992).
 40. Wachinger, G., Renn, O., Begg, C. & Kuhlicke, C. The risk perception paradox-implications for governance and communication of natural hazards. *Risk Analysis* **33**, 1049–1065 (2013).
 41. Grothmann, T. & Reusswig, F. People at risk of flooding: Why some residents take precautionary action while others do not. *Natural Hazards* **38**, 101–120 (2006).
 42. Paton, D. Disaster preparedness: a social-cognitive perspective. *Disaster Prevention and Management* **12**, 210–216 (2003).
 43. Meyer, M. A. Social Capital in Disaster Research. in 263–286 (Springer, Cham, 2018).
 44. Murphy, B. L. Locating social capital in resilient community-level emergency management. *Natural Hazards* **41**, 297–315 (2007).
 45. Aldrich, D. P. The externalities of strong social capital: Post-tsunami recovery in Southeast India. *Journal of Civil Society* **7**, 81–99 (2011).
 46. Quarantelli, E. L. A Social Science Research Agenda For The Disasters Of the 21st Century: Theoretical, Methodological And Empirical Issues And Their Professional Implementation. in *What is a disaster: New answers to old questions* (eds. Perry, R. W. & Quarantelli, E. L.) 325–396 (Xlibris Corp., 2005).
 47. Mathbor, G. M. Enhancement of community preparedness for natural disasters. The role of social work in building social capital for sustainable disaster relief and management. *International Social Work* **50**, 357–369 (2007).
 48. Siegrist, M. & Cvetkovich, G. Perception of hazards: The role of social trust and knowledge. *Risk Analysis* **20**, 713–719 (2000).
 49. Becker, J. S., Paton, D., Johnston, D. M., Ronan, K. R. & McClure, J. The role of prior experience in informing and motivating earthquake preparedness. *International Journal of Disaster Risk Reduction* **22**, 179–193 (2017).

50. Cialdini, R. B. *et al.* Managing social norms for persuasive impact. *Social Influence* **1**, 3–15 (2006).
51. Mileti, D. S. & Darlington, J. D. The Role of Searching in Shaping Reactions to Earthquake Risk Information. *Social Problems* **44**, 89–103 (1997).
52. Sorensen, J. & Sorensen, B. V. Community processes: Warning and evacuation. in *Handbook of disaster research* (2007).
53. Thompson, R. R., Garfin, D. R. & Silver, R. C. Evacuation from Natural Disasters: A Systematic Review of the Literature. *Risk Analysis* **37**, 812–839 (2017).
54. Lindell, M. K., Prater, C. & Perry, R. W. *Introduction to Emergency Management*. (2006).
55. McClure, J., Ferrick, M., Henrich, L. & Johnston, D. *Risk judgments and social norms: Do they relate to preparedness after the Kaikōura earthquake?* (2016).
56. McIvor, D. & Paton, D. Preparing for natural hazards: Normative and attitudinal influences. *Disaster Prevention and Management: An International Journal* **16**, 79–88 (2007).
57. Morrison, D., Lawrence, C. & Oehmen, R. Community Level Influence on Individual Behaviours: Final Report for the Human Behaviour Under Stress Project. *Psychology* (2014).
58. Paton, D. & Bishop, B. Disasters and communities: promoting psychosocial wellbeing. in *Psychological Aspects of Disaster: Impact, Coping, and Intervention* (eds. Paton, D. & Long, N.) (Dunmore Press, 1996).
59. Paton, D. & Johnston, D. Disasters and communities: Vulnerability, resilience and preparedness. *Disaster Prevention and Management: An International Journal* **10**, 270–277 (2001).
60. Paton, D. Preparing for natural hazards: The role of community trust. *Disaster Prevention and Management: An International Journal* **16**, 370–379 (2007).
61. Paton, D. Risk communication and natural hazard mitigation: How trust influences its effectiveness. *International Journal of Global Environmental Issues* **8**, 2–16 (2008).
62. Solberg, C., Rossetto, T. & Joffe, H. The social psychology of seismic hazard adjustment: Re-evaluating the international literature. *Natural Hazards and Earth System Science* **10**, 1663–1677 (2010).
63. Becker, J. S., Paton, D., Johnston, D. M., Ronan, K. R. & McClure, J. The role of prior experience in informing and motivating earthquake preparedness. *International Journal of Disaster Risk Reduction* **22**, 179–193 (2017).
64. Johnson-George, C. & Swap, W. C. Measurement of specific interpersonal trust: Construction and validation of a scale to assess trust in a specific other. *Journal of Personality and Social Psychology* **43**, 1306–1317 (1982).
65. Sjöberg, L. Risk Perception by the Public and by Experts: A Dilemma in Risk Management. *Research in Human Ecology* **6**, (1999).
66. Kee, H. W. & Knox, R. E. Conceptual and methodological considerations in the study of trust and suspicion. *Journal of Conflict Resolution* **14**, 357–366 (1970).

67. Bronfman, N. C., Cisternas, P. C., López-Vázquez, E. & Cifuentes, L. A. Trust and risk perception of natural hazards: implications for risk preparedness in Chile. *Natural Hazards* **81**, 307–327 (2016).
68. Haynes, K., Barclay, J. & Pidgeon, N. The issue of trust and its influence on risk communication during a volcanic crisis. *Bulletin of Volcanology* **70**, 605–621 (2008).
69. Renn, O. & Levine, D. Credibility and trust in risk communication. *Technology Risk and Society* **4**, 175–218 (1991).
70. Fouchier, C. *et al.* *Lessons from the autumn 2014 flash floods in the city of Nîmes and its neighborhood (France): behavior of several mitigation dams and hydrological analysis.* (2016).
71. Agence d'Urbanisme et de Développement des Régions Nîmoise et Alésienne. *Quartier Richelieu-Nîmes. Premiers éléments d'analyse urbaine.* www.audrna.com (2009).
72. Jamot, C. & Thuilliez, B. *Commune de Nîmes Etude d'une stratégie d'intervention sur le quartier Richelieu.* www.urbanis.fr (2014).
73. INSEE. Dossier complet – Commune de Nîmes (30189). <https://www.insee.fr/fr/statistiques/2011101?geo=COM-30189> (2021).
74. Pla, G. *et al.* ESPADA: un outil pour la gestion en temps réel des crues éclaircies urbaines en pleine modernisation. *La Houille Blanche* **1**, (2009).
75. Martin, X. *et al.* *Plan de protection contre les inondations de Nîmes.* (2006).
76. Guillier, F., Larrue, C. & Nussbaum, R. Les PAPI: Quelle efficacité d'un dispositif fédérateur pour la réduction de la vulnérabilité collective aux inondations ? *La Houille Blanche* **2016**, 12–18 (2016).
77. Fournier, J.-P. *3 octobre 1988 - 3 octobre 2008 : du PPCI au programme CADEREAU.* (2008).
78. Sjöberg, L. Worry and Risk Perception. *Risk Analysis* **18**, 85–93 (1998).
79. Reghezza-Zitt, M. & Jon, I. Gestion des risques et des crises, entre gouvernance de la sécurité et gouvernance territoriale. Ce que la résilience change (ou pas) en Île-de-France. *L'Espace Politique* (2019) doi:10.4000/espacepolitique.5463.
80. Touili, N. *Management of multiples risks in urban areas: An integrated multi-risks analysis model for a general resilience.* (2018).
81. Reid, K., Beilin, R. & McLennan, J. Shaping and Sharing Responsibility: Social Memory and Social Learning in the Australian Rural Bushfire Landscape. *Society and Natural Resources* **31**, 442–456 (2018).