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Assessing the Role of Learning and Collaborative Practices in the Operationalization of Flood Resilience: a Comparative Case Study of Nice and Copenhagen

verfasst von / submitted by

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Abstract

With heavy urbanization and climate change, cities are expected to become increasingly vulnerable to floods. Flood resilience emerged as a compelling theoretical framework to assess the capacity of an urban area to cope with (short term) and adapt to (long term) flood episodes.

By comparing two European cities that recently experienced flooding (in 2011 for Copenhagen and 2015 for Nice), this research aims to provide a better understanding of the effects of learning and collaboration in forging and operationalizing flood resilience, by paying special attention to how actors coordinate and whether strategic plans encourage collaborative principles to tackle flooding. Hence, the leading question of this thesis is: how do learning and collaborative practices contribute to the operationalization of flood resilience in urban planning and climate adaptation plans in Nice and Copenhagen?

Content analysis of climate adaptation, flood risk management, and urban planning plans coupled with expert interviews were conducted to gain a more nuanced view of the barriers to operationalizing flood resilience. The analysis of the collected data demonstrated that a holistic approach to flood risk management strategies is required, whereby lessons learned from experience and exploration learning in order to adapt to climate change do prove very useful, not to say essential. Yet, poor collaboration amongst different levels of government, and the precipitated construction of new urban development may impede long-term changes.

Keywords: Flood Resilience- Flood Risk Management Strategies- Exploitation and Exploration Learning- Collaborative Governance- Nice- Copenhagen

Abstract in German

Angesichts der starken Verstädterung und des Klimawandels wird damit gerechnet, dass Städte zunehmend durch Überschwemmungen bedroht sind. Hochwasserresilienz ist ein anerkannter theoretischer Rahmen, der bewertet wie ein städtisches Gebiet (auf kurze Sicht)

Überschwemmungen bewältigt und sich an Überschwemmungsepisoden (auf lange Sicht) anpasst. Durch den Vergleich zweier europäischer Städte die von Überschwemmungen betroffen wurden (Kopenhagen im Jahr 2011 und Nizza im Jahr 2015), konzentriert sich diese Masterarbeit auf die Auswirkungen welches Lernen und Kollaboration bei der Entwicklung und Umsetzung von Hochwasserresilienz haben. Besonders wird darauf geachtet, wie sich Akteure koordinieren und ob strategische Pläne die Zusammenarbeit zur Bewältigung von Überschwemmungen fördern. Die Leitfrage dieser Thesis lautet: Wie tragen Lern- und kollaborative Praktiken zur Umsetzung von Hochwasserresilienz in Stadtplanungs- und Klimaanpassungsplänen in Nizza und Kopenhagen bei?

Es wurde eine Inhaltsanalyse von Klimaanpassungs-, Hochwasserrisikomanagement- und Stadtplanungsplänen in Verbindung mit Experteninterviews durchgeführt, um einen umfassenden Blick auf die Hindernisse bei der Operationalisierung der Hochwasserresilienz zu erhalten. Die Analyse der gesammelten Daten hat gezeigt, dass ein ganzheitlicher Ansatz für Hochwasserrisikomanagement-Strategien erforderlich ist, wobei sich die aus den Erfahrungen erworbene Erkenntnisse und das explorative Lernen für die Anpassung an den Klimawandel als unverzichtbar erweisen. Die mangelhafte Zusammenarbeit zwischen den verschiedenen Regierungsebenen und der übereilte Bau neuer Siedlungen können jedoch langfristige Veränderungen behindern.

Schlüsselwörter: Widerstandsfähigkeit gegen Hochwasser- Strategien für das Hochwasserrisikomanagement- Lernen durch Nutzung und Erforschung- Kooperative Governance- Nizza- Kopenhagen

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List of Acronyms

DREAL: Direction Régionale de l'Environnement, de l'Aménagement et du Logement (Regional Department of the Environment, Planning and Housing)

EU: European Union

FD: Floods Directive

FRe: Flood Resilience

FRM: Flood Risk Management

FRMPs: Flood Risk Management Plans

FRMSs: Flood Risk Management Strategies

MS: Member States

NCA: Nice Côte d'Azur

PAPI : Programmes d'action de prévention des inondations (Action Programme for Flood Prevention)

PGRI : Plan de Gestion des risques d'inondation (Flood Risk Management Plan)

PFRAs : Preliminary Flood Risk Assessments

PPRi : Plan de Prévention des Risques Inondation (Flood Risk Prevention Plan)

PLUm: Plan Local d'Urbanisme Métropolitain (Metropolitan Master Plan)

SGRI: Stratégie de la Gestion des risques d'inondation (Local Strategy of Flood Risk Management)

SMIAGE: Syndicat Mixte pour les Inondations, l'Aménagement et la Gestion de l'Eau maralpin (Mixed association for floods, urban development and water management)

SUDS: Sustainable Urban Drainage Systems

TRI: Territoire à Risques importants d'Inondation (Territory at high risk of flooding)

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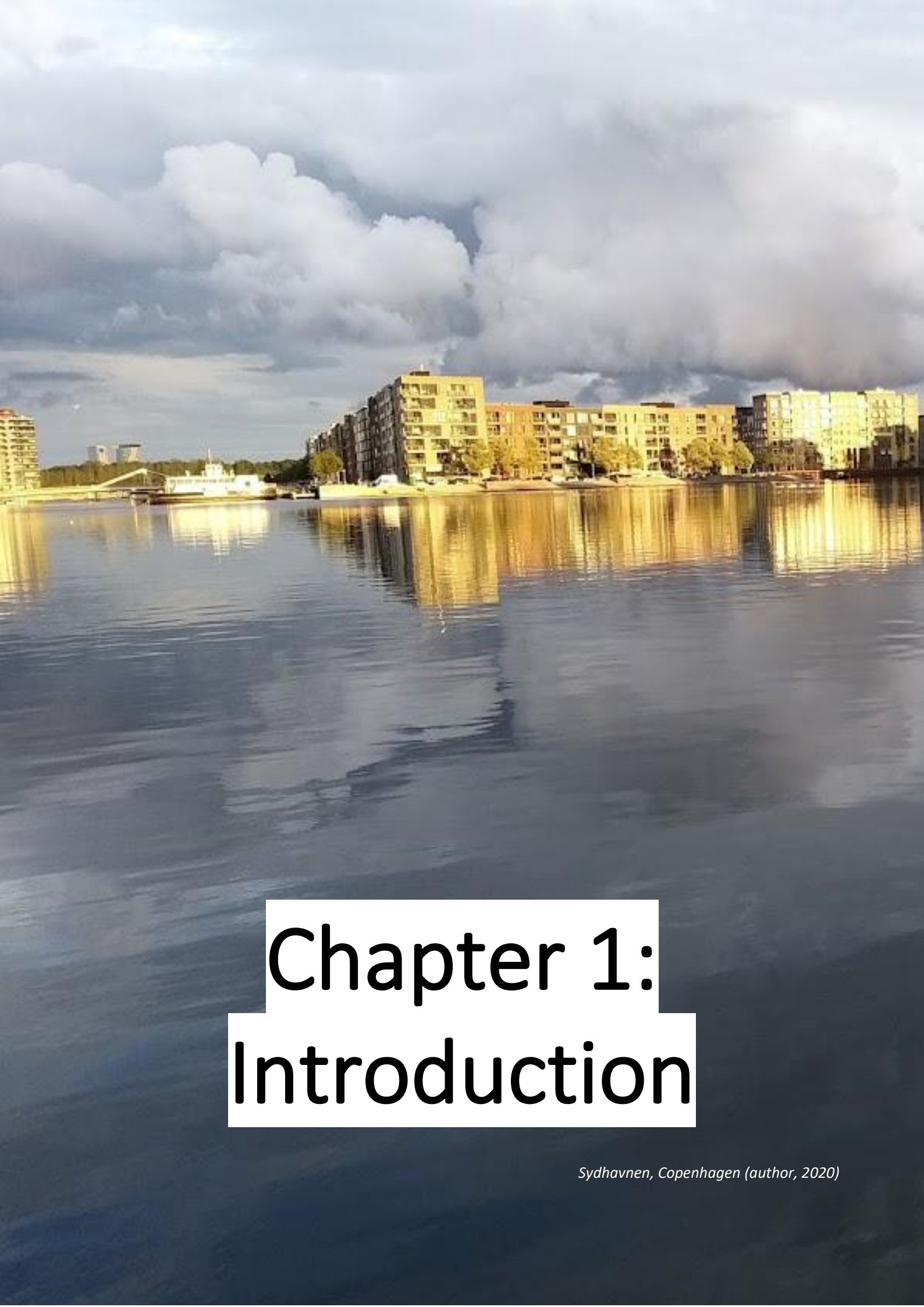


Chapter 1: Introduction

Sydhavnen, Copenhagen (author, 2020)

1.1 Background Information

The overarching purpose of this study is to examine the role of collaboration and learning in operationalizing flood resilience (hereafter FRe). Nowadays, with heavy urbanization and climate change, cities are expected to become increasingly vulnerable to flooding. It is noteworthy to clarify that, while floods are the result of multiple phenomena, such as topography, precipitations, and soil saturation, climate change is likely to exacerbate their intensities and magnitudes (Denchak, 2019).

According to the United Nations, floods are "the greatest damage potential of all natural disasters worldwide and affect the greatest number of people" (UNISDR, 2002, p.6). The European Central Bank mapped the exposure levels to floods and sea level rising of Member States (hereafter MS) accompanied by a chart of economic losses between 2005-2016 *(see figure 1 and table 1 p.5).* Undeniably, the critical likelihood of floods across MS and their underlying human and economic losses, call for the development of innovative practices.

Resilience, which refers to "the ability to resist, absorb, or recover from a shock" and adapt to change (Driessen et al., 2018, p. 1; Fournier et al., 2016), emerged as a compelling theoretical framework to assess the capacity of an urban area to cope with (short term) and adapt to (long term) flood episodes (Neuvel, 2009). It is argued that FRe can be achieved in three ways: the construction of resilient infrastructure; enhanced learning practices (through social and/or institutional learning) and enhanced communication/collaboration and relationships amongst actors (Cumiskey et al., 2019). This work focuses on the latter within the realm of flood governance. Learning and collaborative practices belong to the theory of socio-ecological or adaptive resilience, which acknowledges that man-made and ecological systems are subject to slow altering drivers of change and disturbances that break with the stability of a system over time (Zevenbergen et al., 2020). Socio-ecological or adaptive resilience is defined as "the capacity of linked social–ecological systems to absorb recurrent disturbances such as floods so as to retain essential structures, processes and feedbacks" (Zevenbergen et al., 2020, p.4) where learning and adaptation are affixed capacities. For simplification, the concept of flood resilience (FRe) refers to socio-ecological flood resilience, and will be further explained and adapted throughout this work.

1.2 Research Problem

International discourse promotes narratives on building resilience. Within the framework of FRe, different and fuzzy understandings of its definition impede its operationalization. FRe is often only

referred to as the capacity to recover from a flood event (Kuang & Liao, 2020) and bounce back to the initial state prior to the disaster. These studies have traditionally focused on flood remedies relying heavily upon structural measures (e.g. infrastructure). Recent studies go beyond this notion and include adaptation to change and transformation (Bertilsson et al., 2019). Adaptation can either be incremental (i.e. a series of short-term adjustments) or transformational (i.e. long-term structural changes). It seems that in addressing climate change and flood events, actions are still based on incremental adaptations, having short-term benefits.

At the same time, with increased urbanization and climate change, floods are expected to become more intense and more frequent, putting more pressure on flood-prone cities. Given the likelihood and disastrous consequences of flooding, climate adaptation discourses have surfaced in relation to Flood Risk Management (hereafter FRM).

The great challenges faced by FRM request learning (from past experiences and future-oriented innovations) and coordination between different stakeholders from different disciplines. FRM is translated into strategies involving prevention, protection, preparedness and response, mitigation, and recovery which are carried out by a myriad of actors. It also calls for a holistic approach to step away from the reactionary nature of resilience and include views on spatial planning and urban development, which can be instrumental in preventing floods.

The lack of learning practices and collaboration/coordination among different stakeholders in flood related matters creates a knowledge gap, putting the lives of millions of people at risk. Addressing flooding through the framework of socio-ecological resilience that incorporates views not only on engineering fixes (i.e. flood protection) but also on institutional issues would contribute to long-term FRe. However, it appears that the operationalization of FRe is still in its preliminary stages and calls for clarity.

1.3 Research Aims, Objectives, and Research Question(s)

The goal of this thesis is to investigate the role of learning practices on the one hand, and on the other hand, collaboration practices in operationalizing FRe. To this end, a comparative analysis was conducted by examining similarities and differences in how resilience is addressed in Nice (France) and Copenhagen (Denmark).

This study's objective is fourfold: to compare FRe approaches in two European cities which recently experienced flooding; to identify the role of collaborative and learning practices in the operationalization of FRe in Nice and Copenhagen; to understand the connections between FRM and urban planning; and to diagnose institutional obstacles that hinder changes in these case studies.

This work is thus guided by the following research question: **How do learning and collaborative practices contribute to the operationalization of flood resilience in urban planning and climate adaptation plans in Nice and Copenhagen?**

Four supporting questions were formulated to further this study:

- How important is learning in achieving flood resilience?
- How much of flood related issues/flood resilience is included in broad urban development plans?
- Are flood episodes isolated catalysts for governance change or can they trigger sustainable systemic transformations?
- What are the institutional barriers to flood resilience?

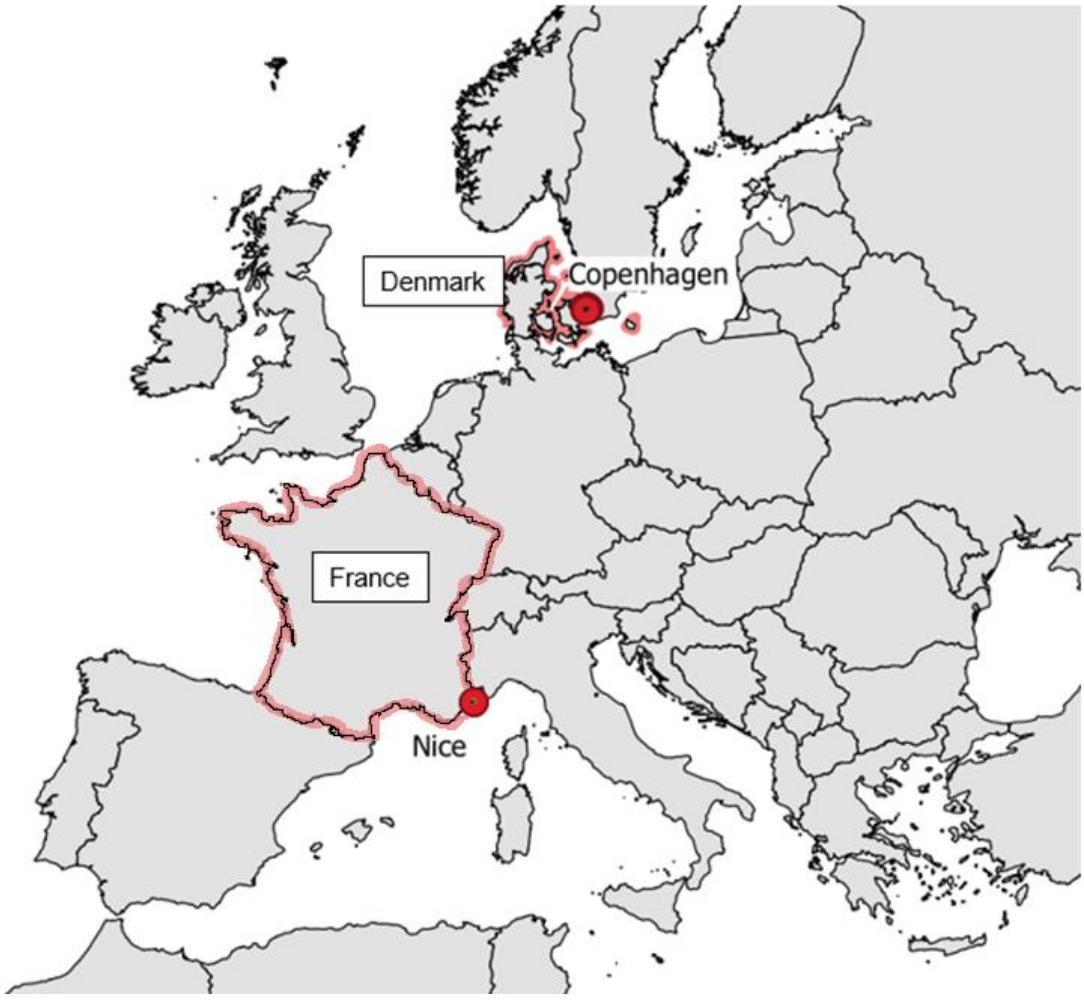


Figure 3: Map of the case studies (author's elaboration using gvSIG Association software Copyright 2009)

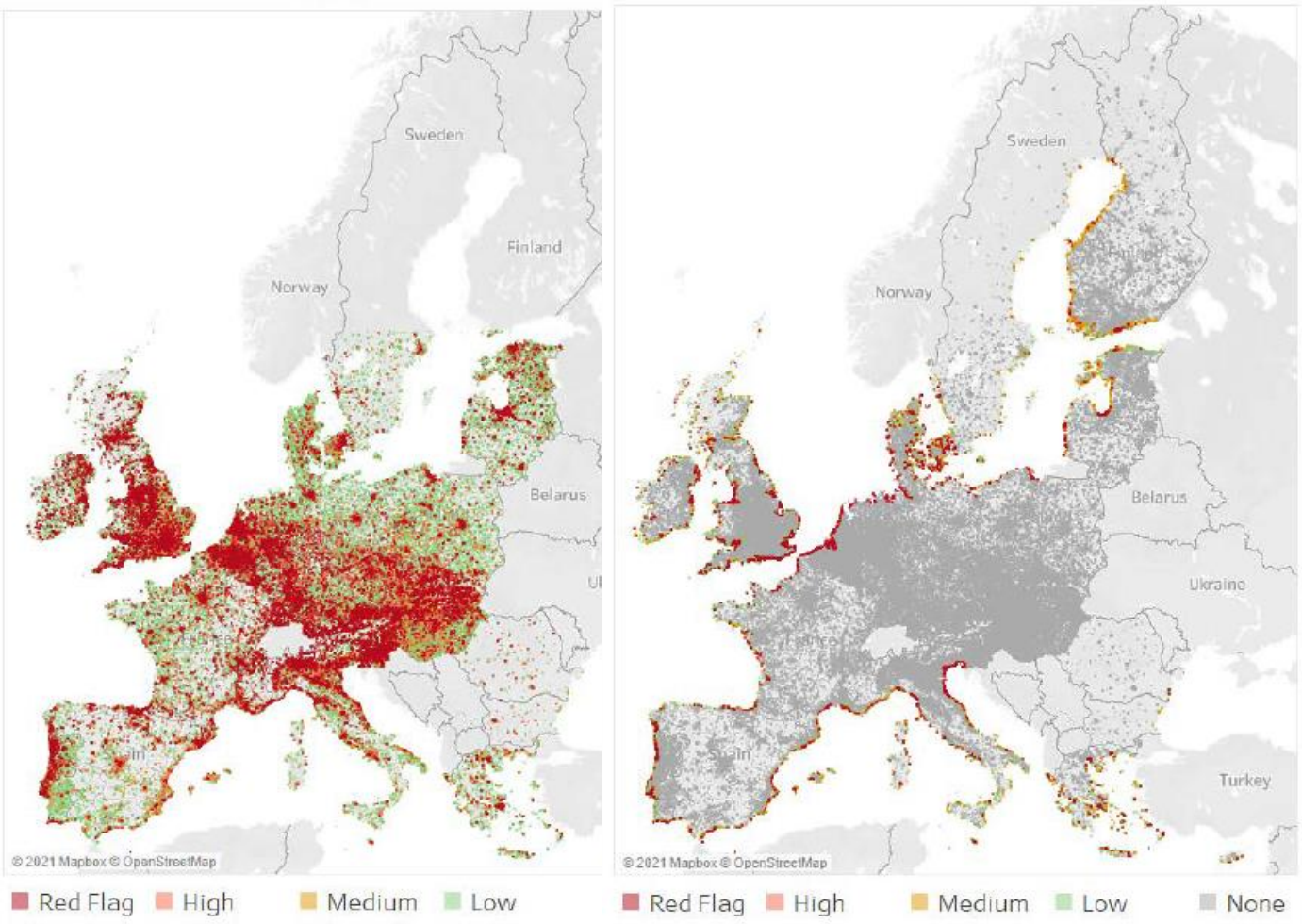


Figure 2: Exposure levels to floods (left) and sea level rising (right) for 1.5 million firms in Europe. Four Twenty Seven, ECB calculations. (European Central Bank, 2021)

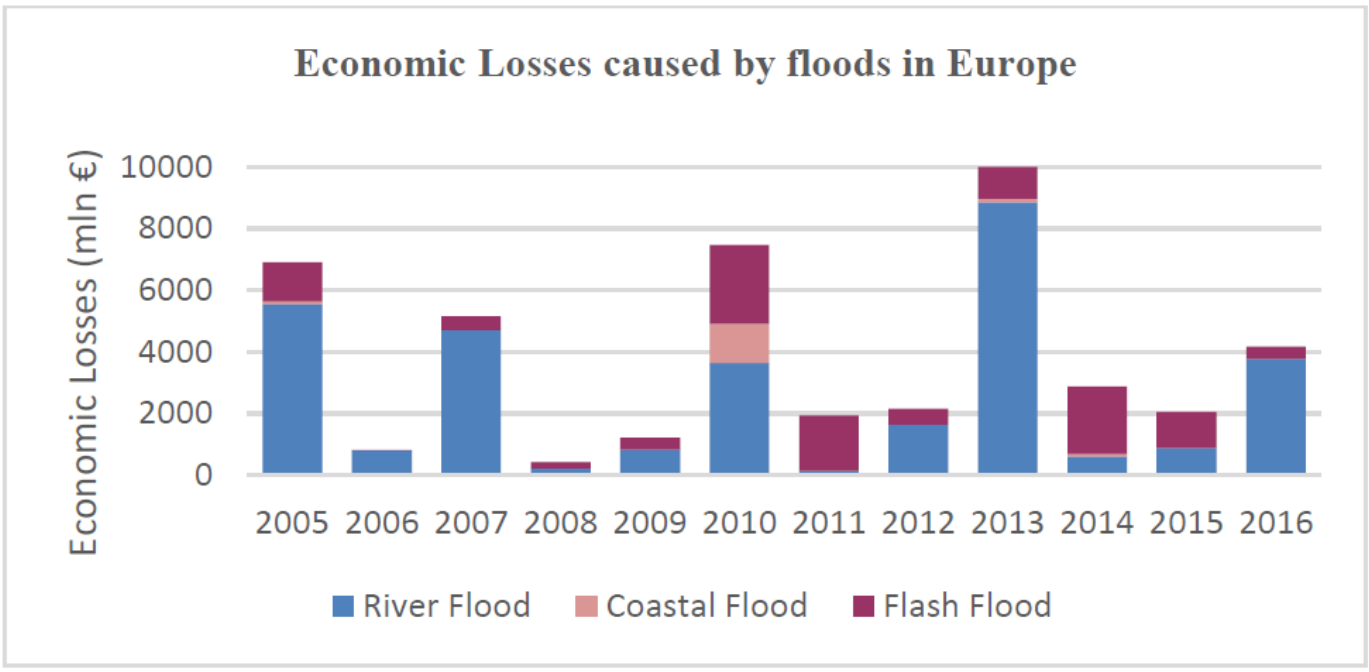


Figure 2: Economic Losses caused by floods in Europe (EUR millions) JRC Risk Data Hub. (European Central Bank, 2021)

1.4 Research Significance

The significance of this research pertains to the analysis and comparison of current FRM strategies and measures in two given cases, Nice and Copenhagen. Taking a chronological approach to FRM by investigating strategies before, during, and after flooding, combined with an assessment of individual approaches to FRe, aims to shed new light on the operationalization of FRe.

1.5 Thesis Outline

This thesis will first review the literature, focusing on the evolution of FRM approaches in relation to urban planning agendas, the emergence of resilience, and the development of adaptive governance through collaboration and learning methods. A description of the chosen methodology together with a case study rationale, will be provided. Results will be enumerated and discussed in chapters 5 and 6. Overall take-aways will be stated in the conclusion chapter.

Chapter 2: Literature Review

Coulée bleue, Nice city centre (author, 2019)

This chapter reviews the literature by first focusing on FRe and governance and then on learning practices in institutions. In regard to the literature review¸ a thematic approach was chosen. First, I will focus on the evolution of FRM to distil important insights from the (past and current) debates revolving around flood and the emergence of FRe. Then, learning practices in institutions regarding collaborative planning and adaptive governance will be discussed.

2.1 A shift from Flood Protection to Flood Risk Management Strategies

Evidently, flood events are becoming more frequent and more intense. Approaches to resist floods have evolved drastically. This section traces the evolution of FRM approaches on which FRe is based today.

2.1.1 The limits of a Resistance-Based Approach

Traditionally, solutions to prevent flooding from occurring were resistance-based strategies. The underlying assumption was that floods can be avoided by constructing protection infrastructure such as dams, drainage systems and dikes. Liao (2012) specified that flood-control infrastructures are constructed under the obsolete assumption that variability of natural hazards does not change over time. Infrastructure also becomes obsolete as it can only resist natural disasters to a certain degree of intensity and magnitude.

Although large-scale embankments and channelization have consequentially protected urban areas from severe floods, this approach to flooding does not allow for adaptation. Moreover, according to Morrison et al. (2018), a resistance-based approach "does not cope well with uncertainty" (p.291). This approach appears costly to build and upkeep, but more importantly, it is very costly in terms of "human life, property and infrastructure particularly when infrastructure or regulatory controls fail to provide adequate protection against surprise events" (Morrison et al., 2018, p.291).

Nowadays flood risk management strategies (hereafter FRMSs) go beyond flood resistance and include a myriad of strategies at the different stages of a flood: before (prevention, defence, and mitigation), during (preparedness and response), and after (recovery) (Driessen et al., 2018). FRM is defined as "all (types of) activities that address the exposure, hazard and consequences of flood risk, enacted through the five FRM strategies previously mentioned" (Gilissen et al., 2015, p. 12). Research has shown that there has been a shift from flood protection towards FRM that breaks with the sole

consideration of infrastructure fixes. It relies on a more holistic approach to build FRe. Driessen et al. (2018) enumerated strategies governments should adopt to achieve FRe, which is defined as the "ultimate and desirable outcome of flood risk management" (Driessen et al., 2018, p.2). According to Driessen et al. (2018), before a flood, prevention is primarily concerned with spatial planning (reallotment and expropriation in flood-prone areas). Flood defence (or protection) deals with infrastructure while mitigation focuses on zoning to lower the magnitude of a flood event. During a flood event, preparation and response guarantee warning systems and disaster management. In the aftermath of a flood, the reconstruction and losses compensation are included in flood recovery strategies (Driessen et al., 2018). Zevenbergen et al. (2020) argued that the concept of resilience has had a major impact on the evolution of FRM over the past decades and is responsible for the shift from structural risk-based strategies to a more holistic approach to FRe.

Until recently, countries that experienced flooding tended to focus on one of the abovementioned strategies omitting others, which contributed to having short term fixes. For instance, flood defence and increasingly prevention were the main concerns in France while in Belgium, flood strategies were directed towards prevention and mitigation (Driessen et al., 2018). Even though countries are faced with different flood episodes with different intensities and frequencies, they should address all stages of FRM to be more proficient in coping with and adapting to floods.

A diversification of countries' portfolio (i.e. strategies) is expected to improve FRe and enable governments to tackle resilience capacities (Driessen et al., 2018; Fournier et al., 2016). The diversification of FRMSs is a necessary step to better grasp flooding and reduce its likelihood and impacts, as well as build up resilience. However, it can also lead to fragmented FRM structures, with poor collaboration, and a mismatch between actors' responsibilities and governing rules enacted by different policy realms (Gilissen et al., 2015). Enhanced interconnectedness within FRM systems is thus seen as a remedy to overcome the shortcomings of a fragmented FRM structure (Driessen et al., 2018). Bertilsson et al. (2019) added that a clear allocation of responsibilities and a formal hierarchy with bodies appointed to enhance coordination are needed to overcome this obstacle. Water management, urban planning, emergency management and other sectors dealing with FRM should address approaches ranging from prevention to recovery.

2.1.2 The Integration of Flood Risk Management in Urban Development

Flood vulnerability has been growing simultaneously with increasing demands for urban development leading to "the overuse of land in flood-prone areas" (Ran & Nedovic-Budic, 2016, p.68). The late

1990s marked a major turning point as land-use planning started to be addressed in relation to FRM in order to mitigate the repercussions of flooding. Yet, poor coordination among institutional scales, (and between urban planning and FRM) impedes the integration of spatial planning in flood risk plans. Ran & Nedovic-Budic (2016) argued that "the relationship between planning systems and flood-risk management is weak and should be strengthened and better coordinated" (p.70).

Urban managers are now faced with uncertainties and risks that need to be addressed. Discourses on building resilience have surfaced in the fields of politics, economics, and natural risk management. However, linking concerns about flood risk and urban development remains problematic. Between 1990s-2010s, considerable flood events occurred in Europe leading to the prioritizing of spatial planning and proactive planning as a response to flooding. Prevention strategies developed a focal point on spatial planning. While research has proven that spatial/urban planning and FRM (especially flood prevention) should go hand in hand, divergences in "priorities, interests, experiences, cultures or beliefs" have hindered changes (Gralepois, 2020, p.5). Gralepois (2020) compared planning instruments and the evolution of flood prevention in France, England and the Netherlands. In France spatial planning and FRM were historically addressed separately. Nowadays, the local government is responsible for urban planning while the State (national scale) is in charge of FRM. The separation of responsibilities shed light on controversies (such as building on unbuildable flood-prone zones) pertaining to inadequate flood governance (Gralepois, 2020). In England, the legal system generates planning instruments in flood prevention (top-down approach) while the Netherlands implemented "incentive-based instruments" that are diversified (Gralepois, 2020, p.9). England and France are thus very dependent upon hierarchical top-down legal structures.

2.1.3 The Influence of Collaborative Planning in Flood Risk Management Strategies

Recent studies on FRM have shown that collaborative planning principles are progressively integrated in FRMSs. According to van Herk et al. (2011), collaborative planning is required to bring FRM and urban planning together. The concept of collaborative planning was first coined by Patsy Healey in the 1980s. Healey (2003) argued that collaborative planning is first "an interactive process" (p.104), and is embedded in governance activities. Building upon Anthony Giddens' (1984) "structuration theory", Healey (2003) discussed the "continual interaction between, and mutual constitution of, structure and agency" (Healey, 2003, p.106). When collaborative planning emerged in planning practices, it was seen as a framework to evaluate governance processes. Healey (2003) claimed that planning activities call for social interactions that she later called "episodes of planning practice" (p.109). The notion of "episodes" is interesting when one examines FRe as floods are often seen as catalysts for change or

as an “episode of planning practice” prompting adjustments in risk perception, policy-making and actors’ coordination, that will be further discussed in the forthcoming sections.

Collaborative planning also relates to communication networks. Communication within institutions can be formal when it takes the form of governments’ decisions and laws or informal through colloquial networks. Mattila (2016) compared the standpoints of Habermas and Healey in dealing with collaborative planning. Mattila (2016) stated that according to Habermas, while informal communication networks have an important role to solidify formal institutions, laws institutionalize ideals and formal structures. Healey deviated from this analysis by assessing the communicative networks and everyday interactions of planners that can arguably be instrumental to normative change at a macro-scale (Mattila, 2016). Indeed, the latter –informal everyday networks– are relevant to adaptation schemes for they can result in innovative policies. FRM calls for both formal and informal communication in different settings. For example, formal communication in a multi-scalar instance is needed to enact plans and policies while informal communication between departments in a given city can improve stakeholders’ relationships.

The actors’ ability to communicate and their relationships are classified into 3 influential mechanisms: bridging mechanisms (with transfer, coordination and cooperation); policy cooperation and integration; and procedural instruments aimed at facilitating coordination (Cumiskey et al., 2019). Gilissen et al. (2015) developed a framework to assess bridging mechanisms whose main goal is to share, inform, coordinate policies and cooperate within the EU. Bridging mechanisms in FRM emerged from a EU funded project entitled STAR-FLOOD. The authors defined this concept as inter-linkage between actors intended to intensify interactions and overcome fragmentation difficulties (Gilissen et al., 2015). They found three main difficulties in FRMSs, namely the “lack of relevant information/experience, one policy can hinder another, and mutual dependency in goal achievement” (Gilissen et al., 2015, p.16). The bridging mechanisms that counteract these difficulties are: transfer of knowledge, coordination and cooperation. Additionally, integration is a flourishing concept that aims at promoting enhanced alignment in “policy domains, and to manage trade-offs and maximize synergies across management practices” (Cumiskey et al., 2019, p.1). Integration is particularly interesting to manage wicked problems as they are particularly subject to uncertainties, divergent interests and multiscalar stakeholder participation. The approach of integration “focuses on understanding the interdependencies across sector objectives, and working within governance structures to manage them” (Cumiskey et al., 2019, p.1). It ranges from adaptation to climate change to risk reduction and urban/spatial planning. Embedded in the theory of governance, integration must be visible in both policies and practices. The EU Water Framework Directive (WFD;2000/60/EC) and

the Floods Directive (2007/60/EC) (hereafter FD) attempt to do so by having integrated approaches in water management and FRM. Yet, while it seems to be the key to many problems, integration is difficult to implement as it is time-consuming and the actors' responsibilities within governance are often blurry, which adds to FRM fragmentation.

According to Hartmann & Spit (2016), FRM is abreast of a similar paradigm shift "triggered, or rather institutionalized, by the flood risk management plan" (p.364). This is particularly visible in the EU with the creation of the FD that legitimates a more holistic approach to FRM. Shifting from a resistance-based approach towards FRM with its diversified strategies leads to collaborative practices and calls for adaptive multi-scale governance. Evers et al. (2016) argued that the creation of the EU FD stemmed from this shift as the directive "demands flood risk assessment, FRM plans and the involvement of interested parties in the implementation process as a new approach to dealing with FRM" (p.335).

Collaboration in FRM outplays exchange of knowledge and information as it allows stakeholders to come up with a shared vision and underlying strategies that supersede individual interests (Heinzlef et al., 2020). In order to promote such a work environment, Heinzlef et al. (2020) organized collaborative workshops in Avignon (France), Québec City and Montréal (Canada) to assess the level of collaboration. The authors found out that coordination and cohesion were still poor as the knowledge gap between scientists/experts and urban managers persisted. Knowledge and institutional siloes may be overcome by creating organizational resilience and collaborative workplaces.

2.2 The Emergence of Resilience

2.2.1 Defining Resilience

Resilience is a conceptual framework used by a variety of disciplines to "evaluate the ability or capacity of a person, object, entity, or system to persist in the face of disruptions or difficulty" (Laboy & Fannon, 2016, p.39). Resilience was first used in psychology and ecology in the early 1970s, then in engineering and it has been applied more recently to natural hazard management (Laboy & Fannon, 2016; Liao, 2012). Given its rather abstract definition, its various uses and applications, resilience pertaining to urban issues is now classified into four domains: technical (built environment), organizational (government and institutions), social (vulnerabilities and adaptations) and economic (economic innovation and reorganization) (Laboy & Fannon, 2016).

Resilience is very often discussed in the wake of turbulences and disasters that trigger "reactionary resilience" based upon observations and experiences. According to Laboy & Fannon (2016) the

reactionary aspect of resilience creates a path dependent condition that reproduces existing structures and "lock-in" scenarios (p.41). Literature on resilience has shown that a holistic view rather than a "specified resilience" approach prevents recent experiences from overinfluencing changes, as "specified resilience" tends to only focus on one approach such as risk mitigation.

The concept of "urban resilience" emerged in the 1980s and originally related to low-income communities' ability to resist economic hardships. Urban resilience is growingly covered in regard to natural disasters, climate change events and recovery processes. In the 2000s, the concept of resilience was first used in relation to risk management (Heinzlef et al., 2020). For instance, urban resilience to floods considers two broad categories: engineering resilience and ecological resilience. The former pertains to the disturbances that impact how engineering systems function; while the latter –ecological resilience—is concerned with "the persistence, or remaining within the same regime defined by the same processes, structures, feedbacks, and identity" (Liao, 2012, p.3).

FRe is anchored in climate resilience and refers to the ability to "resist, absorb or recover from a shock (such as an extreme flood)" and adapt to change (Bertilsson et al., 2019, p.971). FRe can be achieved in three ways: the construction of resilient infrastructure (i.e. drainage basins); enhanced learning practices (social and/or institutional learning); and enhanced communication/collaboration and relationships amongst actors (Cumiskey et al., 2019). Relevant to this thesis are the learning and communication/collaboration practices that are intended to build and/or enhance FRe. The concept of socio-ecological resilience is used here to assess the role of learning and collaboration in operationalizing FRe. It is relevant as it sheds light on the importance of social interactions in forging resilience. According to Zevenbergen et al. (2020), socio-ecological resilience provides a guidance for building up resilience and is founded on:

i. "accepting that knowledge will never be perfect and that changes are uncertain and hence that there is no 'optimal' or 'best' solution;
ii. taking a long-term view, while nurturing the capacity to monitor and learn from intermediate outcomes and to adapt (short-term incremental changes) and keep options open to transform (long-term system changes);
iii. taking into account all of the potential interventions that may alter flood risks (ranging from flood preparedness to prevention); and
iv. facilitating participation and collective action and learning" (p.6)

2.2.2 Flood Resilience and Development Plans: A Mismatch?

The concept of resilience is particularly relevant when one examines sustainability and climate change that both gained recognition in the 1970s. Resilience is increasingly used in regard to FRM with

resilience being “the ultimate and desirable outcome of flood risk management” (Driessen et al., 2018, p.2). The abovementioned shift from a resistance-based approach to flood risk management strategies (FRMSs) has led resilience to be increasingly linked to sustainability (see figure 4 p.14). Reghezza-Zitt (2010) argued that in development plans, discourses on sustainability leading to resilience convey a positive and attractive argument in favour of FRM. Flood risk may become a territorial asset promoting urban betterment through renewal projects. For instance, in Nice the so-called Eco-Valley project was designed to build a brand-new city in a flood-prone area. The project was first converted into the “Operation of National Interest Var Plain” co-launched by the national and local authorities. However, this project is heavily criticized by local organizations for “both negligence of flood risks and a lack of transparency” (Bertilsson et al., 2019, p.9). The use of the word “resilience” in urban projects is thus likely to be used as a buzzword to attract investors and developers rather than a way to build a more resilient city.

Handayani et al. (2019) used content analysis to examine how FRe is operationalized in development plans in two coastal cities in Indonesia (Samarang and Tegal). The Indonesian authorities –at national and local levels of government–in the two abovementioned cities have integrated the notion of resilience in their plans as this notion (and its synonyms) is given more attention in development plans. Although FRM gained importance in urban development plans, resilience is not necessarily used in the context of flooding but disproportionately in the context of economic resilience and in the broader context of sustainable development (Handayani et al., 2019). Using content analysis, the authors were able to demonstrate that the word “resilience” is often used to discuss food and economic resilience rather than disaster management. Their method was instrumental to identifying discrepancies in the allocations of key terms such as resilience and their misuse (i.e. usage of a buzzword).

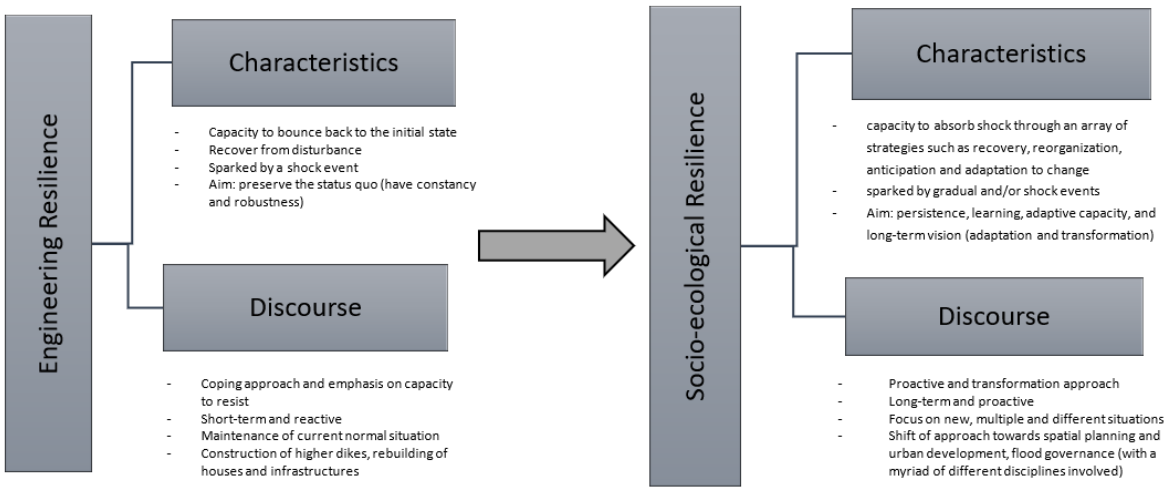


Figure 4: Frameworks of resilience, adapted from Handayani et al. (2019) and Zevenbergen et al. (2020)

2.2.3 Climate Adaptation and Flood Resilience

Adaptation embodies a major stage towards resilience. It is often understood in relation to climate change. There are two types of adaptation: on the one hand incremental adaptation which consists of a series of actions and adjustments targeting the reduction of losses and the increase in benefits from a natural disaster. On the other hand, transformational adaptation is concerned with technological and behavioural changes within a structural transformation in a given society (Kates et al., 2012). Incremental and transformational adaptations can be responsive (i.e. in the aftermath of a natural disaster) or anticipatory (i.e. prior to a shock event) (Kates et al., 2012). The accumulation of incremental adaptations may lead to transformational adaptation. Yet, incremental adaptations are very punctual and short-term driven. While transformational adaptation –especially anticipatory– seems to be the way to go forward, its implementation is difficult. Transformational adaptation is driven by uncertainty, increased vulnerabilities and climate change which entail large investments and costs (Kates et al., 2012). Transformational anticipatory adaptation also faces institutional and behavioural barriers as it applies to legal, social, societal and institutional understanding and risk perception. Kates et al. (2012) asserted that in dealing with climate change, "the most promising approach is to promote risk management given uncertainties" (Kates et al., 2012, p.7159).

2.2.4 How is Resilience addressed in Policies?

With FRMSs, Driessen et al. (2018) demonstrated that a legal framework balancing legal certainty (to ensure one's rights) and flexibility is needed to foster adaptation and thus resilience. The authors showed that the enforcement of the FD in 2007 was a first step (at the supranational level) to have a common framework by developing flood hazard maps and assessments. This initiated the formal legal certainty of FRe. Yet, as the FD is a voluntary directive, its impacts are quite limited. Member States are still responsible for the implementation of FRMSs giving them more flexibility in the decision-making process.

Resilience is a rather new notion, and its understanding and upscaling vary from one context to the other. For example, the concept of resilience has appeared very recently in the French legal framework. According to Reghezza-Zitt (2010) planning documents in France such as Flood Risk Management Plan (PPRI), Action Programme for Flood Prevention (PAPI), and Specialized Zonal Flood Contingency Plans (PSSIZ) did not use the word «resilience » until very recently (2010s). This can be explained by a very different context from the Anglo-Saxon world. Indeed, the concept of resilience is disproportionally used in Anglo-Saxon instances compared to French examples. Reghezza-Zitt (2010), identified two main reasons for this discrepancy. On the one hand, natural hazards studies —that

developed the concept of vulnerability—are based upon a multidisciplinary approach that includes social sciences such as sociology and urban geography. Coping and adaptation capacities are therefore viewed not only in their physicality but also through the lens of social sciences. On the other hand, adaptation is seen as positive leverage in regard to climate change. French and Anglo-Saxon approaches to vulnerability account for differences in systemic values. The French legal system focuses on vulnerability which has a negative connotation while Anglo-Saxon countries tend to have a more positive analysis by including resilience.

Heinzlef et al. (2020) compared how resilience is articulated in France and Canada. Based on the case of Avignon (France), the authors asserted that resilience is "hardly integrated into its systems" while in Québec (Canada) resilience is defined as "the ability of a system to maintain or restore an acceptable level of operation despite disruptions or failures" by the Ministry of Public safety (Heinzlef et al., 2020, p.6). Resilience in the Canadian context is thus not only addressed but also operationalized by institutions. Moreover, the authors claimed that an organizational resilience approach (that is developed in the Canadian model) stems from a "mode of operation that promotes interorganizational collaboration" which helps to overcome silo models and enhances key relationships between different actors of risk management (Heinzlef et al., 2020).

FRe is thus very complex to achieve as it sometimes contradicts individual interests and development goals. A clear understanding of what it entails seems to be pivotal in elaborating a more adaptive and resilient system.

2.3 Flood Governance: An Adaptive Governance based on Collaboration, Cooperation and Communication Mechanisms

The preceding section described FRe and its different understandings and uses. This section discusses flood governance which enables resilience. After broadly defining the concept of governance, the need for adaptability and multi-scale coordination will be studied in relation to flood governance.

2.3.1 Defining (Adaptive) Governance

Governance encompasses governmental institutions, non-governmental activities and actors that rely on formal and informal mechanisms to reach common goals (Mäntysalo & Bäcklund, 2018). This concept departs from the idea that the "government" is the only ruling entity. Taking an urban planning approach, the shift from government to governance enabled a shift from "statutory planning

toward governance-based strategic spatial planning" (Mäntysalo & Bäcklund, 2018, p.244). A neo-institutionalist perspective coupled with an interpretive policy analysis guided Healey (2004) to view "governance institutions not as a set of formal organizations and procedures established in law" but rather a set of "norms and standards (…) which shape both formal and informal ways of thinking and ways of acting" (p.15). Nowadays urban planning is faced with three contemporary issues (neoliberalism, globalization and climate change) that dictate all urban strategies. These contemporary issues entail changes within governance structures so that they can be more adaptive.

Building on the work of Cosens and Williams (2012), Fournier et al. (2016) defined adaptive governance as a "governance process whereby multiactor collaboration and coordination at multiple scales provide the necessary feedback mechanisms to inform appropriate responses to environmental challenges" (Fournier et al., 2016, p.3). In order to build FRe, adaptive governance is therefore a necessity. Indeed because of the complexity of floods, having interfaces with social, economic and ecological dimensions, collaboration between diverse organizations with diverse backgrounds is required. Additionally, the notion of adaptive governance is commonly addressed in relation to vulnerability and resilience: the former being reduced and the latter enhanced (Reghezza-Zitt, 2010).

2.3.2 Flood Governance

Flood governance is particularly difficult to implement as administrative boundaries do not necessary align with water catchment or water systems (Dieperink et al., 2018). Moreover, flood governance is concerned with social interactions, policy-making and stakeholders' engagement as it involves different stakeholders from different levels of government and different expertise in one municipality. Collaboration between these different institutional units is needed to ensure the drafting and implementation of plans.

The literature on flood governance draws attention on multilevel governance and collaborative governance (Dieperink et al., 2018; Bertilsson et al., 2019). Indeed, FRe (that results from flood governance) in the European context is concerned with the diversification of strategies, adaptation, and participation (Gralepois, 2020). Diversification of strategies may diverge greatly from one country to the other. However, FRMSs always call for a multiplicity of actors working at different scales of government. Therefore, by virtue of its complex nature, FRM entails a multi-scalar governance which is also seen as a prerequisite to building or enhancing FRe. For instance, in France, the departmental level of government takes care of the upkeep of defence infrastructure, is responsible for the fire brigade and the preparation of actions in collaboration with the municipal level (Bertilsson et al., 2019). The local scale of government (municipal and intermunicipal) has a pivotal role in prevention

and mitigation strategies. Since the 1990s, the State has enforced the implementation of Flood Prevention Plans that have trickle-down effects on local governments (Bertilsson et al., 2019).

Enhanced communication amongst different actors thus facilitates the creation of flood governance. In Copenhagen, the Three Points Approach (3PA) (see figure 5 p. 18) was introduced to build up urban resilience and disaster preparedness. This approach is threefold: technical optimisation (mainly with urban drainage systems); spatial planning (having a future-oriented perspective on urban development to forge urban resilience); and day-to-day values which are concerned with public participation and awareness (Fratini et al., 2012). The 3PA's main goal is to facilitate the decision-making process by acknowledging the complexity of the urban context and flood risk, and by promoting interdisciplinarity (Fratini et al., 2012). Lerer et al. (2017) used the 3PA to assess the performance of urban stormwater systems in Copenhagen. The authors concluded that this method also allows for better communication between stakeholders as the evaluation of urban drainage systems is performed in a comprehensive manner that can be understood by experts and decision-making civil workers. However, the 3PA is limited in two ways: it lacks clarity to elucidate uncertainties in climate projections; and in terms of water management, design standards are often obsolete and cannot face more extreme precipitations than anticipated (B. R. Rosenzweig et al., 2018). Nonetheless, it remains a conclusive example of flood governance as stakeholders learn to better communicate.

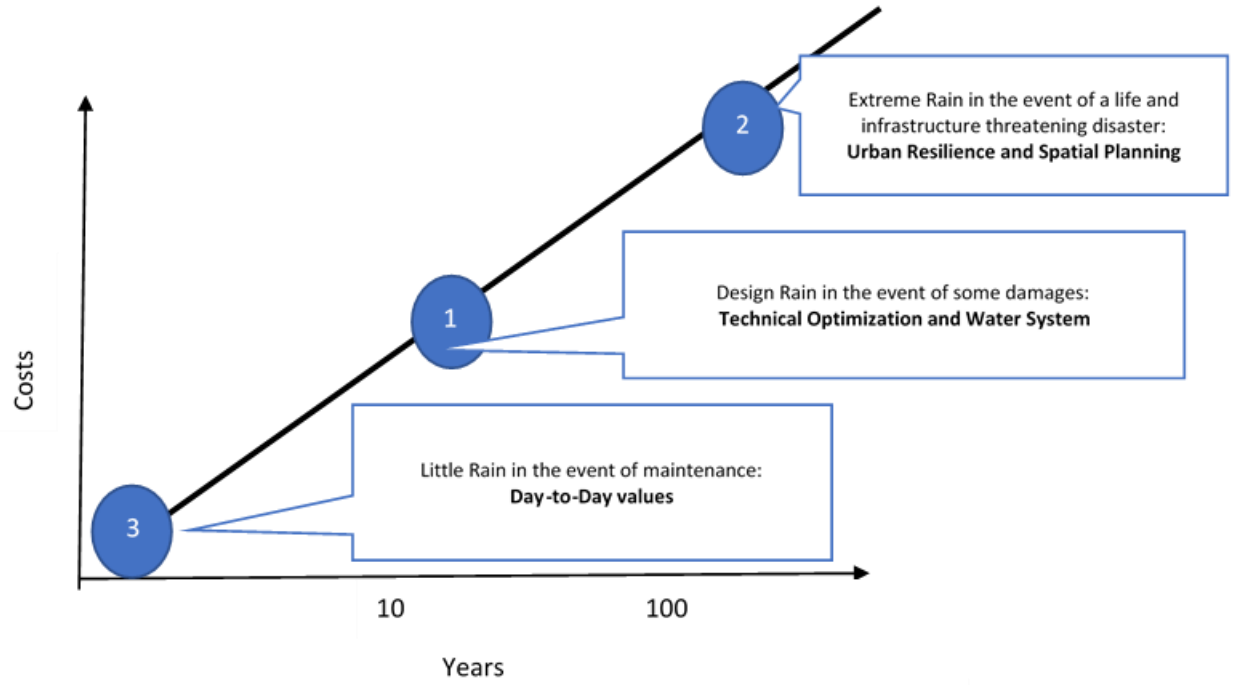


Figure 5: The Three Point Approach, adapted from Fratini et al. (2012)

As seen throughout this literature review, FRe is subject to a number of obstacles impeding its implementation. This thesis focuses primarily on flood governance that is arguably a decisive step

toward resilience. Flood governance thrives on integrated and holistic approaches that acknowledge the multi-disciplinary nature of FRM. Yet, an integrated flood governance collides with 6 "boundaries": "knowledge, practice, priority, scale, institutional histories, and language" (Ishiwatari, 2019, p.2). Building on the work of Becker (2018), Ishiwatari (2019) compared obstacles countries face in designing an integrated flood governance. China encounters difficulties in multi-scale coordination, the Netherlands in "synchronizing multiple programs" and in South Africa, limited capacities, technocracy and political interest are perceived as obstacles (Ishiwatari, 2019, p.2). These various "boundaries" not only show the complexity of FRM, but also the absence of a one-fits-all model that could address all these barriers. Nonetheless, the next section attempts to find areas of research that deal with ways to counteract these barriers.

2.4 The importance of Learning Practices

2.4.1 Context

In this section, I will delve into the learning processes in institutions that can enhance their ability to build resilience. Healey (2004) discussed governance culture by referring to adaptability and flexibility. She asserted that creativity and innovation are intertwined with the notion of "new" which stresses the need for flexibility "both to adjust to new urban situations and to auto-transform in the face of new challenges"(Healey, 2004, p.12). In this context, Healey (2004) also highlighted the importance of learning processes and experimentation. Because of the "dynamic complexity" (Healey, 2004) of urban regions, governance should allow experimentation. Shifting the emphasis from focusing on outcomes towards a culture of evaluation that generates learning practices is –in her view– a prerequisite to build adaptability and flexibility.

However, creating such an environment is a demanding task and subject to risk and uncertainties, especially when dealing with urban issues such as flooding. It is argued that to be truly resilient (and overcome vulnerability) adaptability and transformability are necessary processes to enable a more holistic approach based upon collaboration and cooperation among all levels of governments.

2.4.2 Exploitation and Exploration Learnings

Strategic urban or spatial planning are fundamental in insuring flood prevention as flood vulnerability hinges on land use and zoning regulations. In the realm of strategic urban planning, learning is either an exploitation of gained knowledge from past experiences, or the exploration of what might happen in the future (Hutter, 2007). This dichotomy is particularly interesting when looking at flood risk as

one can learn from past events (exploration) and consider uncertainty and adaptation (exploration). It appears that FRMSs follow this approach as lessons learned from past floods are increasingly incorporated in strategic plans. Meanwhile a forward-looking attitude is noticeable, with different flood risk scenarios examining uncertain events with various magnitudes and frequencies. After recent floods, learning practices have mainly focused on acquiring new knowledge (Hutter, 2007) to learn how to prevent flooding and halt its disastrous effects. Structural (i.e. infrastructure) and non-structural measures are continuously deployed to improve FRM. One may argue that the paradigm shift from flood protection towards FRMSs is a result of learning. Exploitation is directed by past experiences and ambitioned in the near future: "it generates earlier, closer and clearer feedback than exploration" (Hutter, 2007, p.278). The latter –exploration– includes flexibility, adaptation, experimentation, research, discovery and innovation (Hutter, 2007). Both types of learning methods must be combined to be able to foresee uncertainty and understand past events. Yet, learning in institutions is highly dependent upon allocation of resources and the tendency to value exploitation (short term assessment) to the detriment of exploration (longer term agenda) (Hutter, 2007).

2.4.3 How do Learning Practices Help Forge Flood Governance?

Research on policy changes offers an accurate distinction between different types of learning methods. There are four types of learning practices relevant to policy-making. While they differ in some aspects they all draw lessons from past experiences. Instrumental learning is concerned with the improvement of institutional arrangements (especially in their design) to achieve existing policy goals (Connor & Dovers, 2004). Institutional learning also focuses on the lessons learned from institutional instruments put into play, such as policies and changes in political strategies and agendas. According to Haque et al. (2019), institutional learning is more likely to emanate from reactive learning after a disaster and is characterized by single-loop and double-loop learning.

Social learning is rooted in the "social construction of policy problems" and pinpoints the policy itself, tweaking its scope and its goals (Haque et al., 2019, p.149; Connor & Dovers, 2004). According to Evers et al. (2016), "(s)ocial learning can be described as a concept where individuals and organisations learn from and about each other through exchange, dialogue or even conflict" (p.336). Social learning therefore results from a reciprocative reflection whereby the sharing of experiences, ideas and reflections is essential (Haque et al., 2019). The benefits of social learning are threefold: it strengthens the adaptive capacity of a given institution thanks to interactions and dialogue; it can enhance the depth of the learning process especially when it stems from multi-loop learning. It can also act as both "the dynamics of practice" and "governance" leading to "a systemic approach to governance"

(O'Donnell et al., 2018, p.2). According to Ishiwatari (2019) social learning was instrumental in the Netherlands and the UK in supporting collaborative planning and transforming flood governance.

Government learning overlaps with instrumental learning but also extends it, for it "has as its focus the organizational structure and processes of agencies and delivery systems as distinguished form the policy instruments used" (Connor & Dovers, 2004, p.22). Key learners here are senior departmental bureaucrats and in some cases government ministers.

Political learning involves political actors that are concerned with the effectiveness of strategies within a policy agenda (Connor & Dovers, 2004). Policy change is either the manifestation of external causes such as climate change or one of internal causes leading to policy learning. The ability to adapt to climate change requires adjustments and learning processes (Fournier et al., 2016).

To sum up, the literature on resilience has demonstrated that learning at different levels of government and feedback loops boosts the recovery and response dimensions of resilience. Moreover, learning at one institutional scale tends to focus on coping mechanisms that may be reproduced elsewhere (Haque et al., 2019).

2.5 Can Floods be Catalysts for Change?

As already seen, floods are perturbations of sub-systems with many repercussions. While shock events can spark changes in regard to perception of risk, governance and policy-making, their upscaling seems difficult to implement in the long run. This section identifies two main barriers to change: path dependency in institutions and siloed thinking.

2.5.1 Path Dependency in Institutions

When looking at flood governance, Wiering et al. (2018) argued that institutions managing natural resources such as water and public goods tend to be path-dependent preventing adaptation policies. Wiering et al. (2018) determined four elements that contribute to path dependent patterns in flood governance: 1) *fixed costs* especially with FRM infrastructure that always demand large investments; 2) *learning effects* through limited investment in research and development; 3) *coordination effects* pertaining to the difficulty to collaborate with a large number of actors involved; and 4) *adaptive expectations* linked to the history of FRM and the perception of the population (Wiering et al., 2018, p.232).

Considering *learning effects* and *coordination effects* that are of paramount importance in this thesis, learning and collaboration have already received attention from scholars interested in the formation of urban governance. Evidence has shown that a lack of institutional capacity and willingness hinders proactive and forward-looking policies (Haque et al., 2019). In theory, a collaborative approach is highly beneficial as it allows for the formation of an adaptive governance and transfers of knowledge, while reducing costs of cooperation amid policy actors (Ananda & Proctor, 2013). Nonetheless, it seems that the transition from theory to practice is still burdensome. For instance, in Australia, institutional configuration and rules do not lodge flexibility which impedes collaboration (Ananda & Proctor, 2013). In the case of the Province of Manitoba (Canada), a lack of coordination amongst different levels of government and amongst government departments obstruct proactive thinking and future-driven policy-making. First, as communication between different government departments is flawed, learning and sharing innovative ideas cannot be cultivated. This can be explained by the independent character of each department apropos of policies and programmes' implementation, and the shortage in transfer of knowledge between departments. Secondly, communication between the local and provincial levels of government undermine proactive thinking as top-down policies are often disconnected from the local reality and forced by major disaster events (Haque et al., 2019). Handayani et al. (2019) found out that in Indonesia "even though the institutional frameworks were set up and supported by regulations to ensure integrative partnerships, there are still challenges resulting mainly from lack of capacity of the institutions" (p.7). This can be explained by a poor access to information, limited resources, and unclear institutional mechanisms (Handayani et al., 2019).

These are recurrent challenges faced by governance in adapting to floods. Furthermore, it is likely that disasters only lead to minor adjustments in policy changes rather than drastic changes (Haque et al., 2019). Overcoming them seems to be crucial to enabling the emergence of an adaptive governance. This thesis will review the cases of Nice and Copenhagen to figure out the impacts recent floods had on governance and policy changes.

2.5.2 The Perception of Risk and Overcoming Siloed Thinking

Policy change and learning may only occur when senior policy makers, experts, and bureaucrats perceive the risk —and its potential underlying dangers—as high. As long as the risk does not appear to be significant, it is reasonable to think that policies tend to remain stuck in time, for policies are likely to be the direct reaction to an event such as flooding (Haque et al., 2019). According to Hurlbert & Gupta (2016), the "institutional context of governance" responding to extreme events is fundamental in dealing with risk reduction and adaptation (Hurlbert & Gupta, 2016, p.339). They compared adaptive governance to climate change, drought and floods, in Canada, Chile and Argentina.

The authors argued that there remains a policy gap in dealing with wicked problems (i.e. climate change) because of "the lack of utilization of environmental governance approaches" (Hurlbert & Gupta, 2016, p.352).

Interconnectivity in policy framing and risk analysis is needed to improve adaptive governance. Historically, extreme natural hazards have had a major role in shaping new policies revolving around disaster and emergency management (Haque et al., 2019). Taking an international standpoint, the Province of Manitoba in Canada experienced a "flood of the century" in 1997 that led to the amendment of the *Emergency Measures Act* in 1997 followed by the *Disaster Financial Assistance* providing policy guidelines for property losses in the public and private realms (Haque et al., 2019). Extreme flood events are seen as catalysts to prompt changes in FRMSs. Indeed, from a policy viewpoint, a "perturbation external to the policy sub-system is necessary for radical policy change" (Wiering et al., 2018, p.233). However, it can have the opposite effect and solidify existing policies without having drastic changes. As put forward by Haque et al. (2019), it is likely that disasters only lead to minor adjustments in policy changes rather than drastic changes.

Another major obstacle restraining FRe is "siloed thinking" (O'Donnell et al., 2018). Morrison et al. (2018) analyzed 258 papers addressing FRM, FRe and adaptation. They discuss the "siloing in FRM research" arguing that it is a common element of environmental science especially when research, practice and policy-making are involved (Morrison et al., 2018, p.298). FRM literature shows a clear divide between social and physical sciences. Social science tends to focus on governance structures, stakeholder engagement and interactions while physical science is more concerned with the physicality of flooding and tools to overcome urban vulnerability (Morrison et al., 2018). Research on flood governance is mostly involved with practice and policy-making limiting knowledge transfers between practitioners and researchers. Morrison et al. (2018) suggested a more integrated and strategy-based FRM research "for policy agenda" (p.299). Indeed, a more holistic approach to FRM and resilience would fix this research gap by addressing flood risk in an interdisciplinary and transdisciplinary manner.

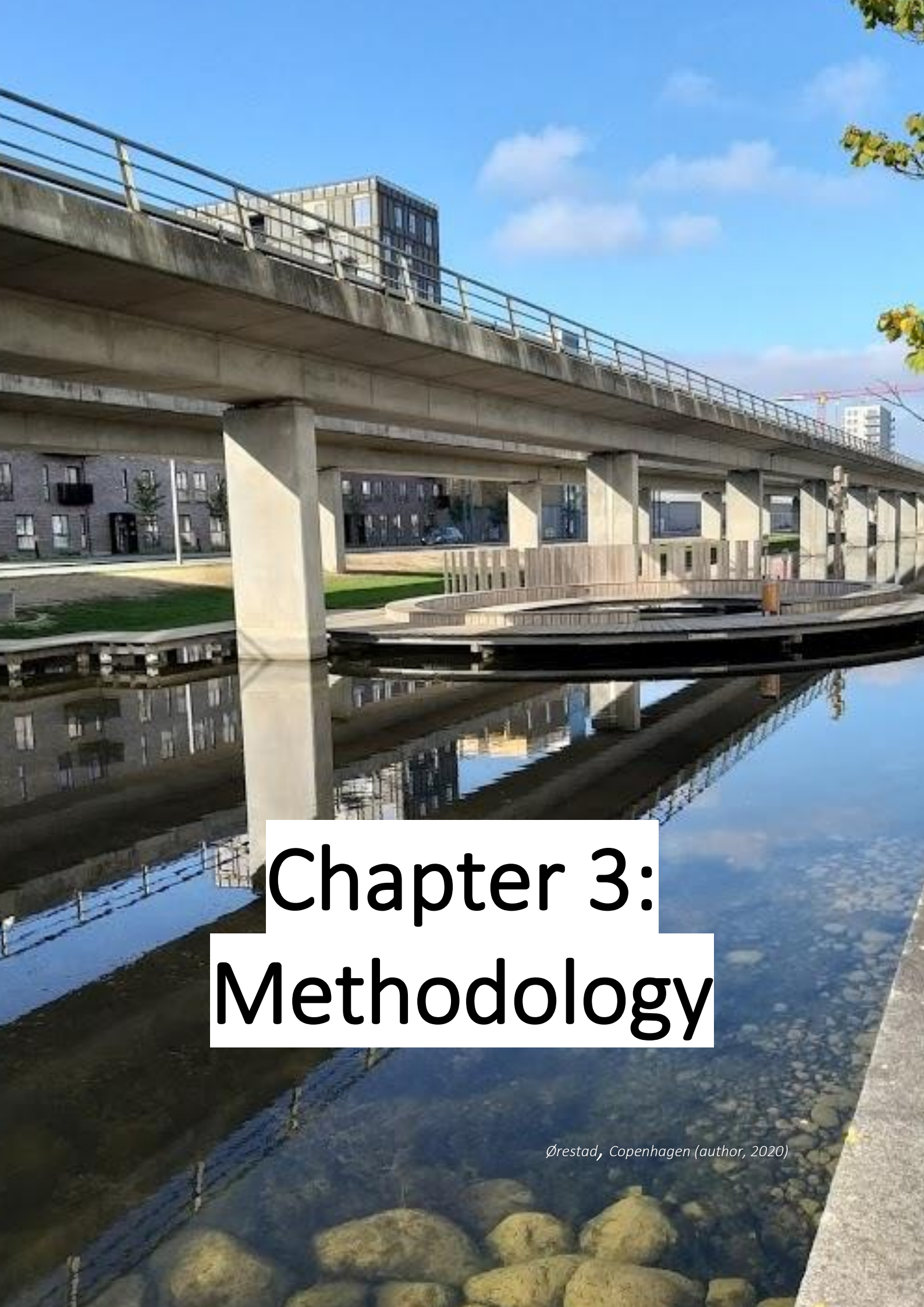
Taking a local example, Copenhagen exemplifies the scaling-up issue of FRM. Copenhagen experienced a one in a-100-years flood in 2011 with unprecedented intensity and severe rainfalls, up to 132mm in the city centre (Madsen et al., 2019). The Cloudburst Plan was published in 2012 stating that pluvial flooding is "deemed the most immediate priority in the municipal Climate Adaptation Plan" (Madsen et al., 2019, p.33). Because of its coastal location, the municipality of Copenhagen produced a new Storm Surge Plan in 2017 to have projections on coastal flooding due to sea level

rises. According to Madsen et al. (2019), the municipality followed the recommendations of engineering consultants. For both plans, the authors assume that the municipality of Copenhagen and experts collaborated but the extent of interdisciplinary, knowledge transfers and learning loops were overlooked in the research. To better apprehend flood, the municipality of Copenhagen decided to invest in surface solutions with grey and green infrastructures such as basins and rain gardens to store stormwater. Thanks to the development of this new type of infrastructure (i.e. multifunctional public spaces), experts believed pluvial floods are less of a priority risk. These innovations were thought of in close collaboration between flood experts/consultants and the municipality. While the 2011 flood has sparked innovative practices and collaboration between experts and the municipality of Copenhagen, experts argue that "legal-regulatory and normative institutions now need to catch up with and accommodate the solutions pinpointed by professionals" (Madsen et al., 2019, p.36). This sheds light on the mismatch between experts' recommendations and the decision-making of institutions often marked by political pressures.

Another interesting case study is that of the Netherlands. Although the Netherlands is considered an "extreme" case of institutionalized safety —which is embedded in the Dutch flood governance—siloed thinking remains. In the mid-1990s, two near-flood events (in 1993 and 1995) redefined political priorities revolving around FRM, landscape, urban planning and ecology, and led to the implementation of the "Room for the River" Plan in 2000. This plan gave momentum to water policy changes with a multiplayer safety approach to flood risk integrating flood defence, spatial and disaster planning, and crisis management (van Buuren et al., 2016). Indeed, the National Water Plan implemented in 2009 introduced a more risk-oriented approach. Bergsma (2016) demonstrated the necessity of knowledge transfer changes to implement spatial planning policies in flood governance strategies in the Netherlands. Floods were catalysts to new flood safety/protection programmes, such as for the abovementioned River program first initiated in 1990s followed by the Second Delta Program in 2007. While the case study of the Netherlands seems to overcome the knowledge gap between science and policy-making, it fails to go beyond the science-policy interactions by considering other relevant standpoints such as geographers' and behavioural economists' (Bergsma, 2016).

2.6 Conclusion

The goal of this literature review was to identify key trends in the theory of FRe and observe how concepts from different disciplines namely policy-making, engineering, governance studies have shaped the way FRe is perceived and implemented. A major breakthrough was the shift from the resistance-based flood risk approach to diversified FRMSs. The diversification of FRMSs induces a holistic and multidisciplinary approach that leads to the creation of flood governance. Yet, flood governance is now faced with obstacles that impede its expansion. Breaking with the entrapment of siloed thinking thanks to collaboration, cooperation and learning practices is arguably a way to overcome barriers to governance change. The urgency of flooding calls for adaptive and transformative governance able to break with path dependency. This has globally been acknowledged yet practices tend to remain path dependent and frozen in time. By comparing FRe constructions in Nice (France) and Copenhagen (Denmark), the aim of this thesis is to pinpoint local barriers to FRe. The role of learning and collaboration in building up FRe will be examined in the following chapters.



Chapter 3: Methodology

Ørestad, Copenhagen (author, 2020)

3.1 Overview of Methods

3.1.1 Qualitative Research based on a Multiple Case Study Approach

This thesis adheres to the case study approach which is defined as "the study of an issue explored through one or more cases within a bounded system" (Creswell, 2012, p.73). A case study research is seen either as a strategy of inquiry or methodology. Here, based on Creswell (2012)'s argument, I have chosen to consider it part of my methodology as I am exploring the operationalization of FRe in two subjects of interest: Nice and Copenhagen. By comparing two case studies, the objective is to comprehend how learning and collaborative practices can inform the construction of FRe. Moreover, conducting a case study research aims at investigating the context and processes of a phenomenon (e.g. the operationalization of FRe) which sheds light on a theoretical framework being studied (i.e. FRe and governance) (Kohlbacher, 2006).

3.1.2 Expert Interviews

A total of 10 semi-structured interviews were conducted with experts to collect primary data, comprising 5 bureaucrats, 1 engineer, 2 emergency coordinators, 1 project manager, 1 associate professor (table 1 p.30). The interviews targeted specific institutional actors dealing with FRM or climate adaptation. The objective was to assess and compare the acquired data from the content analysis with key actors' views on FRM, collaboration and cooperation between different sets of actors at different levels of governments. The interviewees' approach to FRe was compared using the lens of learning practices in the aftermath of a flood event. Interviews were only held online because of the current global pandemic of Covid 19 (SARS-CoV-2) and were fully transcribed. Transcripts were then coded to detect key themes and patterns using Nvivo a CAQDAS (Computer-Assited Qualitative Data Analysis Software) to reduce biases (Feng & Behar-Horenstein, 2019).

3.1.3 Content Analysis

Based on the interviewees' responses, thirty urban planning and climate adaptation plans were selected. The previously conducted interviews informed the selection of documents as the importance of taking into consideration climate change and urban planning to improve the FRe was mentioned numerous times. Appendix A lists the studied documents and states their significance to this work.

Content analysis seemed to be the appropriate method to interpret climate adaptation, flood risk and urban planning plans to assess whether FRe is being operationalized. It is regarded as a flexible method

used to analyze textual data (Hsieh & Shannon, 2005). It is also described as a subjective interpretation since the researcher chooses what data to analyze. This results in "a systematic classification process of coding" to identify themes and patterns (Hsieh & Shannon, 2005, p.1278). In this work, I used coding which is the "quantitative analysis of qualitative data" (Hsieh & Shannon, 2005, p.1278) using Nvivo (CAQDAS) which permitted me to explore and analyze my diverse data and identify trends and patterns. Based on Saldaña (2013)'s work, patterns were identified to figure out: similarities (when patterns "happen the same way"), differences ("they happen in predictably different ways"), frequency, sequence (when patterns "happen in a certain order"), correspondence ("they happen in relation to other activities or events") and causation (p.6-7).

Before coding, I determined a codebook (appendix C) with codes derived from the literature revolving around FRe, climate adaptation, learning and collaboration practices. This deductive coding method provided a basis to position this work in the literature by harmonizing it with the chosen conceptual frameworks, theories and research aims (Saldaña, 2013). Throughout the process of coding, some emergent codes (e.g. codes that were inducted from the data) were identified. To complement this method, I used keyword extraction (or word count) which refers to the counting of the most representative and repetitive words in a given document. After the first cycle of coding, I codified my data in order to classify and categorize the patterns that were developed throughout the analytical process. This step enables the researcher to build up meaning and corroborate some primary findings (Saldaña, 2013). The data were created based upon major themes, split into categories, subcategories and codes/nodes. The query "word frequency" was run through studied plans. Findings were compared to the initial list of key vocabularies.

For the case study of Nice, an additional source was adjoined to the data collection: the transcript (the author's elaboration) of the TV programme *C Dans l'Air*, which is a panel of experts that aired on October 10th 2020. In the course of writing this thesis, major floods occurred in the region of Nice especially in Breil-sur-Roya, located Northwest of the Metropolitan Area of Nice. On October 10th 2020, 4 national experts debated on the role of institutions in FRM (table 2 p.30). This panel of experts gave more insight into FRMSs at the national level of government in France (France Télévisions, 2020).

3.2 Overview of constraints and limitations

In terms of constraints, I was confronted with a lack of responses especially in the case of Copenhagen. Primary data collected from expert interviews is therefore incomplete as saturation was only partially

met. To compensate this pitfall, additional secondary data were reviewed and incorporated into the study. Furthermore, due to the pandemic of COVID 19, I could not travel to Nice as initially anticipated. Interviewees (limited to French and English) were thus only conducted online or by phone from summer 2020 to spring 2021.

Quantifying FRe –and its operationalization–is challenging as there is no agreement on its definition which leads to a highly subjective analysis of the interaction between actors, learning, or impacts on the built environment. To overcome this shortcoming, a chronological approach of FRMSs in Nice and Copenhagen was undertaken.

Additionally, content analysis has several shortcomings. First, it is highly subjective. Findings rely on the author's interpretations of textual data and interviews. In the case of Copenhagen, the studied plans were simplified translations of official documents in Danish, possibly impeding the in-depth assessment of plans. Moreover, having primary data deducted from the literature review influences the data collection as the researcher is likely to have biases (Hsieh & Shannon, 2005). To circumvent this drawback inductive coding was performed in parallel to word count analysis.

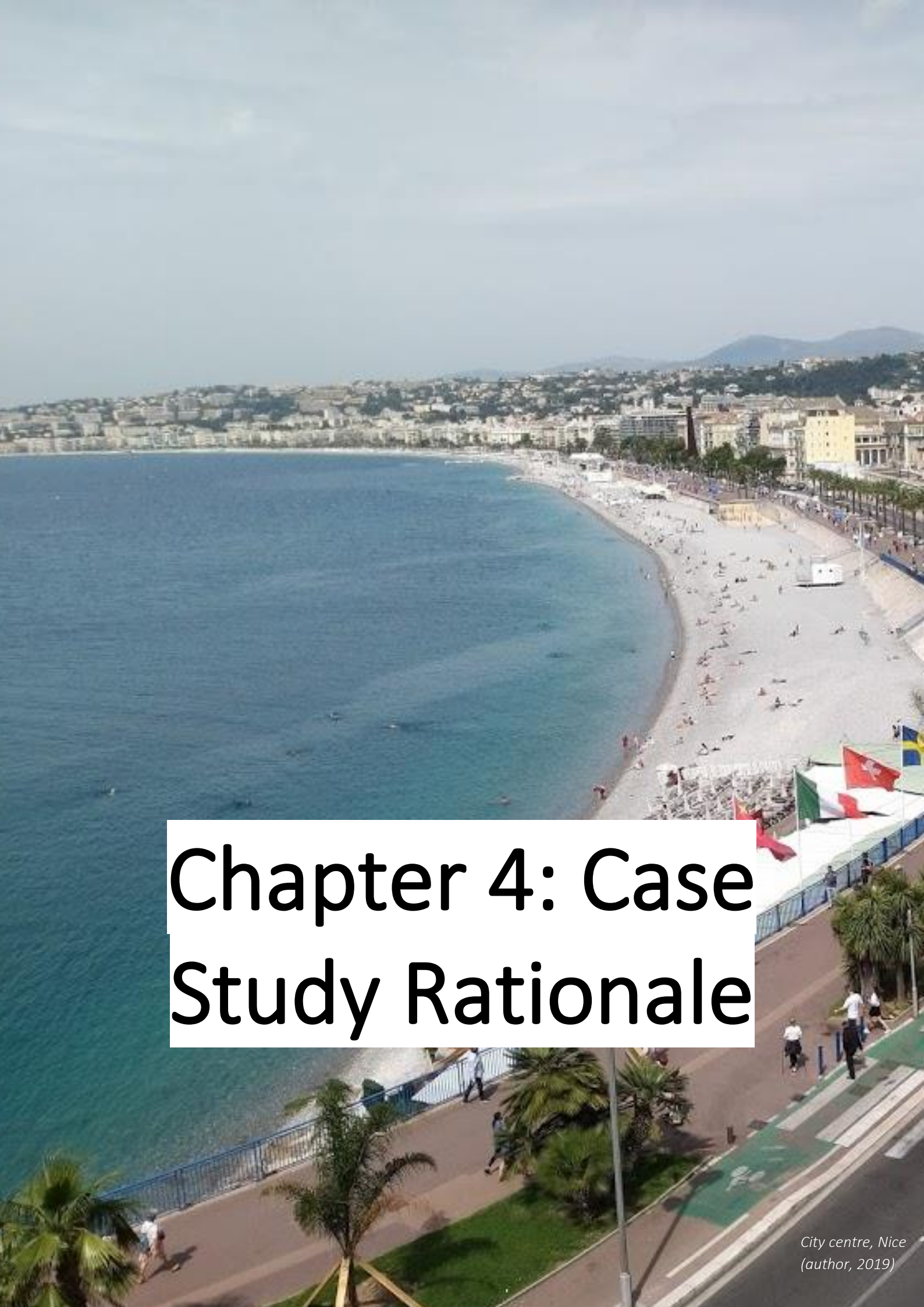
N°	*Occupation of interviewee*	*Institution*	*Date of the interview*
1	Team Leader/ Policy Officer	Floods Directive/ European Commission (EU)	13/11/2021
2	Deputy-Chief of the Travel, Security and Risks Department	Departmental Directorate of Territories and the Sea / Nice (France) *Direction départementale des Territoires et de la Mer (DDTM)*	30/07/2020
3	Head of the Major Risks Department	Prevention and Risk Management Department/ Nice (France) *Direction de la Prevention Et Gestion Des Risques*	04/09/2021 10/09/2021 (follow-up)
4	Executive Assistant	Local Public Basin Establishment/ Nice (France) *Syndicat Mixte pour les Inondations, l'Aménagement et la Gestion de l'Eau maralpin (SMIAGE)*	13/08/2020
5	Crisis and emergency coordinator	Technical and Environmental Administration/ Copenhagen (Denmark) *Teknik- og Miljøforvaltningen*	06/10/2021
6	Engineer	Technical and Environmental Administration/ Copenhagen (Denmark) *Teknik- og Miljøforvaltningen*	06/10/2021
7	Ex Deputy Mayor of Melun in charge of communication	Seine et Marne préfecture (France)	24/07/2020
8	Center Manager	Miljøpunkt Nørrebro, Copenhagen (Denmark)	01/02/2021
9	Chief Consultant and Contingency Coordinator	Frederiksberg Kommune (Denmark)	25/03/2021
10	Associate Professor, Department of Planning	Faculty of Engineering for IT and Design Allborg University, Copenhagen (Denmark)	28/04/2021

Table 1: List of Interviewees

	Name of national expert	*Occupation*
1	Yves Thréad	Editorialist/Journalist and Associate Editor of Le Figaro
2	Béatrice Giblin	Geographer, Professor emeritus at the French Institute of Geopolitics and director of the journal Hérodote
3	Magali Reghezza	Geographer specializing in natural hazards and environmental issues
4	Arnaud Gossement	Lawyer specialized in environmental law, Associate Professor of Law at the University of Paris 1

Table 2: List of National Experts from C dans l'air (TV programme)

Chapter 4: Case Study Rationale



City centre, Nice (author, 2019)

4.1 Background Information

It is important to mention that this work does not focus on one specific type of flooding but tries to understand the mechanisms of FRM and learning that can help forge FRe. Floods in urban areas are the result of several meteorological events such as heavy rainfalls, concentrated precipitations, cloudbursts, rapid snowmelts, storm surges, or embankment failure (Ran & Nedovic-Budic, 2016). Both cities were chosen because they recently experienced flooding: in 2011 in Copenhagen and in 2015 and 2019 in the region of Nice.

4.2 Nice, France

The City of Nice (figure 7) is located in the Metropolitan Area of Nice Côte d'Azur (*Métropole Nice Côte d'Azur*/ NCA) which was created in 2001 and encompasses 49 municipalities between the Mediterranean Sea and Mercantour Mountains (INSEE, 2014). Most of the Metropolitan Area's population is concentrated in the coastal region which is densely urbanized with 454 800 inhabitants and represents 84% of its population. NCA's demographic make-up is evolving as population rates are diminishing significantly: in 2017 its total population was 537 999 inhabitants and the city of Nice's population comprised 340 017 residents (INSEE, 2014).

Figure 6: Bird's Eye View of Nice's city centre, (author, 2019)

Nowadays, NCA has to face the ageing of its population, especially in the hinterland, and emigration to neighbouring regions which are more affordable (INSEE, 2014). The latter causes more commuting travels which became a major challenge along with affordable housing, mobility, quality of life, and attractivity.

4.2.1 Institutional and Administrative Context at the National Level

According to Larrue et al. (2016), the institutional and administrative structures in France are characterized by centralization with a powerful central State and a decentralized organization which relies on State services and territorial/local authorities. States services encompass the Ministry of Environment (renamed the Ministry of Ecological Transition and Solidarity under the current government) concerned with flood prevention and defence; while the Ministry of Interior and the Ministry of Environment deal with preparation. At the regional and departmental levels, decentralized services (*Préfectures*) "are responsible for the control of legality, implementation of the State budget and levying and redistribution among the various territories" (Larrue et al., 2016, p.13). Water agencies that are state public bodies are accountable for water management at the basin level (Larrue et al., 2016). Strategic planning and economic development decisions are made by regional councils and municipalities are in charge of services of proximity.

France has been undergoing a decentralization process since 1982, which has led to power transfers to regional and territorial levels of government. Larrue et al. (2016) mentioned that in accordance with the "general competence" principle, there is no hierarchy and local authorities may make decisions as long as they are legitimized by local public interest. While local authorities have decision-making powers, multi-level powers overlap and convolute decision-making. National flood management strategies comply to the FD regulations. Three levels of government are involved: The State with national strategies; FRM plans (FRMPs) at basin level, and local strategies at municipality level. In France, flood management responsibilities are shared between the central State and the territorial/local level of government. During a crisis, *préfets* (State authority figure) and mayors are liable because they are responsible for the safety of equipment and people (i.e. police powers).

4.2.2 The case of Nice

The Metropolitan Area of Nice Côte d'Azur (referred to as "Nice" is this work) is located in the Region of Provence-Alpes-Côte-d'Azur, in South-eastern France. Nice is a typical Mediterranean city with its underlying geographical and climatic features characterized by dry summers, and irregular rainfalls in the winter (Larrue et al., 2016).

Flood risk in Nice is concerned with river overflows from the Var, Paillons, Cagne, Malvan. The most likely river to overflow is River Var as it is subject to "sudden, violent, torrential flooding" (Bertilsson et al., 2019, p.13) causing significant damages in the region. Growing concerns about sea level rising are more and more apparent in the region. Natural risks supplement already existing urban pressures with a high urban density and a tourism dependent economy relying on housing stocks, transport systems and businesses (Bertilsson et al., 2019).

Nice has been urbanizing along its main rivers: the historic centre of Nice was constructed on the banks of the Paillon while the Var is now the subject of a national intervention in urban development that includes flood risk management (Var Plain Operation of National Interest). Heavy rainfalls in 2015 caused the death of 20 people and damages were estimated at 605 millions of euros across the department of Alpes-Maritimes (France Bleu, 2018).

Coordination among different levels of government is carried out with the Action Programme for Flood Prevention (PAPI) which is a financial and coordination tool that comprises FRMSs (except for recovery). Bertilsson et al. (2019) pointed that while PAPIs aimed at having cohesiveness, they often result in a compilation of measures instead of an "integrated multi-strategic FRM program" (p.8). This fragmentation triggered the creation of the SMIAGE (*Mixed association for floods, urban development and water management)* that tries to initiate informal dialogue to better collaborate amongst different governments while providing technical knowledge especially on flood defence and mitigation (Bertilsson et al., 2019). A final actor in Nice's flood governance is the *Etablissement Public d'Aménagement* (EPA: public development authority). The EPA is the leading authority of the Eco-Valley project and brings together representatives from all levels. The EPA also acts as a mediator between national flood requirements and PAPIs at the local level.

4.3 Copenhagen, Denmark

Copenhagen is the capital of Denmark with a population of 638,117 inhabitants. It is located in the Capital Region of Copenhagen which encompasses 29 municipalities with a population of 1,855,084 residents (Statistics Denmark, 2021). Copenhagen's economy thrives on the manufacturing industry (with 28 000 jobs), trade and tourism (48 000 jobs) and other services (191 000 jobs) (Europa.EU, n.d.) which contributes to its international attractivity. Copenhagen and Frederiksberg (a neighbouring municipality) are exceptions to the Danish institutional structure as they endorse competences that are usually commanded by the county level of government such as health and education. Compared to NCA, the Capital Region of Copenhagen gained more residents thanks to its international attractivity

with an increase of 47,680 inhabitants between 2017 and 2021, and the City of Copenhagen's population growth of 35 636 inhabitants (Statistics Denmark, 2021).

In regard to its climate, Copenhagen has an oceanic climate with a topography varying between 0 and 50m above sea level, and annual precipitations of approximately 600mm (Lerer et al., 2017). This topography makes it particularly vulnerable to storm surges.

4.3.1 Institutional and Administrative Context at the National Level

A 2016 study published by the Danish Centre for Environment and Energy accounted for the leadership of municipalities to steer proactive climate change policies (Alkhani, 2020). Efforts to prioritize climate adaptation were noticeable and Copenhagen is commonly accredited for its sustainable development, climate adaptation and sustainability concerns (Alkhani, 2020).

The State is in charge of drafting plans such as the Preliminary Flood Risk Assessment (PFRA), Areas of Potential Significant Flood Risk (APSFR), Flood Hazard and Flood Map (EU, 2019). At the national level, the Ministry of Environment and Flood of Denmark (MoEF) defines key objectives for municipalities in drafting flood risk management plans. According to the EU report, most APSFR are located along the coast with the exception of Holstebro which is likely to experience fluvial flooding (European Commission, 2018b).

Municipalities are legally responsible for the implementation of FRMPs for both pluvial and coastal flooding within the framework of planning for climate adaptation (EU, 2019; Madsen et al., 2019). FRMPs are established at the municipal level of government as municipalities decide on flood adaptation, level of protection and above ground solutions (Madsen et al., 2019). Coastal flooding adaptation is also addressed at the municipal level with planning authorities undertaking protective interventions.

While Danish municipalities play a pivotal role in addressing flood risk, Alkhani (2020) asserted that the national institutions and planning regulations determine the legal framework and institutional infrastructure in charge of climate change, sustainability, and funding sources that considerably influence the urban development of municipalities.

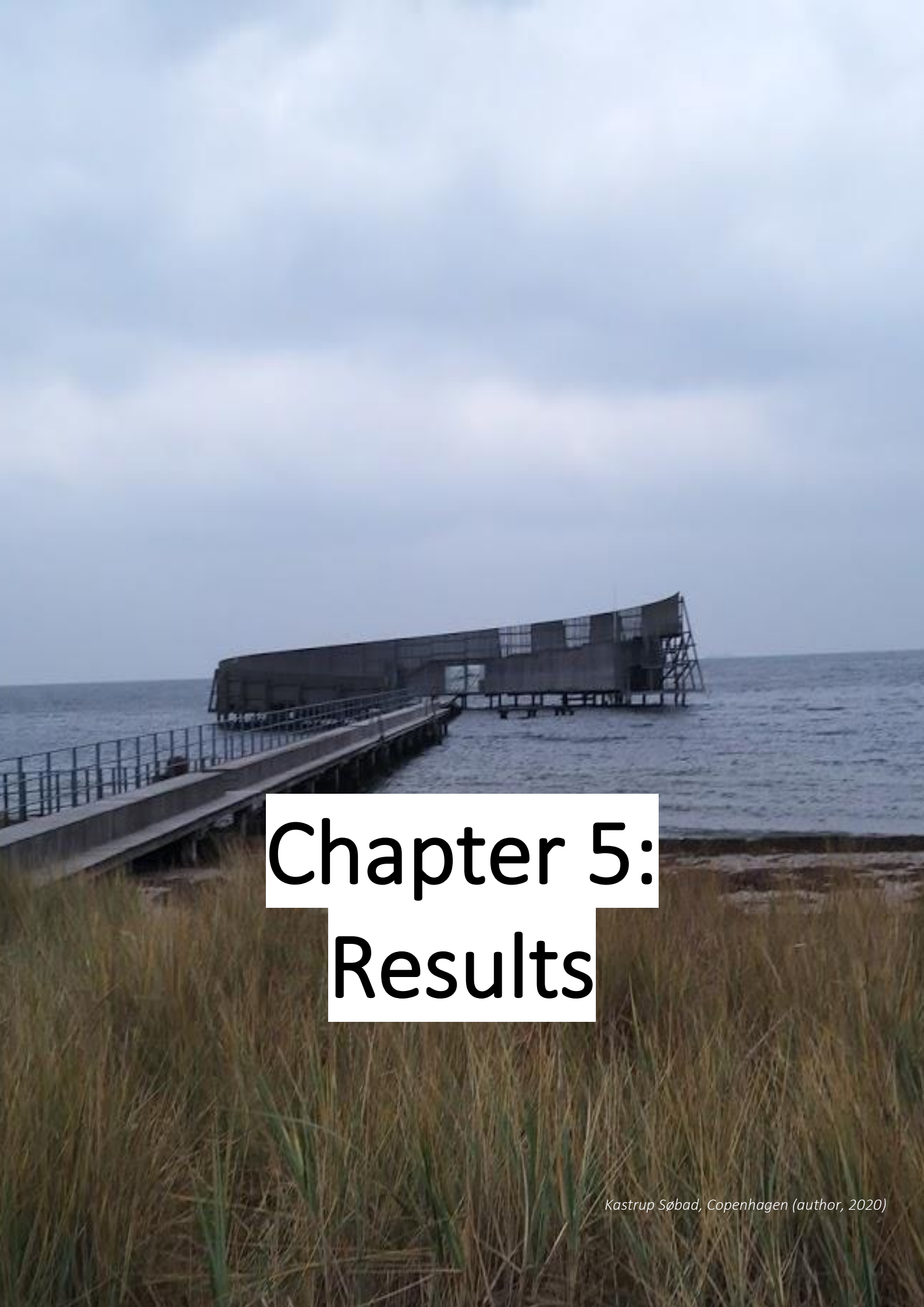
4.3.2 The case of Copenhagen

With its location and densely urbanized core, Copenhagen (see figure 7 p.36) is at risk of coastal and pluvial flooding. Regarding coastal flooding, Copenhagen is prone to storm surges resulting in floods damaging its coastal areas. According to the Danish Meteorological Institute, the sea surrounding

Copenhagen is expected to rise by 1m within the next 100 years with more frequent high-water increases (Alkhani, 2020).

The 2011 heavy rainfall that hit Copenhagen was a wake-up call to alarm the authorities and populations of the municipality's vulnerability to heavy downpours. The Danish Meteorological Institute defines a heavy rainfall as "more than 15 mm of precipitation in the course of 30 minutes" and in July 2011, approximately 100 mm of rain fell down within an hour (City of Copenhagen, 2012). The 2011 downpour caused damage equivalent to DKK 5-6 bn in Copenhagen (approximately €8 bn). As a response, the Cloudburst Management Plan (2012) includes initiatives to build a flood-resilient city costing DKK 3.8 bn (approximately €5 bn). (abid, 2012).

Figure 7: Copenhagen's city centre, the Lakes (author, 2019)



Chapter 5: Results

Kastrup Søbad, Copenhagen (author, 2020)

This chapter evaluates the collected data. First, a broad overview of the studied codes will be discussed through inductive and deductive coding. An in-depth analysis of both case studies will be provided, followed by a comparison of the key findings. The leading question of this work is: how do learning and collaborative practices contribute to the operationalization of FRe in Nice and Copenhagen? The following results help provide an answer for it.

5.1 Inductive Coding

Following an inductive coding method, relevant sentences and paragraphs were coded and sorted into themes. Table 4 (p.34) summarizes word counts of the assigned inductive codes and presents critical findings. The documents were classified into three categories: Copenhagen-Denmark, Nice-France, and the European Union (hereafter EU).

Regarding approaches to FRe, the query "word count" revealed that "resilience" is stated 154 times in 16 documents out of the 30 studied documents. Resilience is not necessarily used in the context of flood events. In plans from Copenhagen, resilience is used in the context of climate adaptation whereas in Nice, it is seen as a goal to achieve at the metropolitan level but does not specify in which domains. The EU tends to discuss economic and financial resilience.

The couple resilience-vulnerability is important to take into consideration to assess the perception of risk. In French documents, the code *vulnerability* is used 6.5 times more than the code *resilience.* In the case of Copenhagen, this gap is less prominent with *vulnerability* only stated 4.6 more times than *resilience.* This means that flood risk is still mostly regarded through the lens of vulnerability rather than resilience.

The group of codes s*patial planning OR urban planning OR development* is the second most frequently used code after the code revolving around *flood*. It has been discussed throughout this work that there has been a shift from flood protection towards FRM with a greater emphasis on prevention strategies (i.e. urban planning). Climate adaptation and FRM plans view sustainable urban planning as leverage to become climate/flood-resilient. Codes from the conducted expert interviews also communicate the importance of spatial/urban planning in the construction of FRe, as urban planning was mentioned 31 times across 10 interviews.

It is important to note that the author opted for a broad understanding of the notion of "collaboration" in which cooperation, communication, and coordination are all included to assess flood governance. The code *Collaboration* is the third most frequently counted code, implying that institutions are aware

of the necessity to reinforce collaboration, cooperation, communication, and coordination of the legal framework. While *learning* has a low absolute frequency, past floods are discussed in documents from the EU (overview of floods in MS), in Copenhagen (2011-flood), and Nice (2015-flood). It is thus understood that institutions take into consideration past experiences to inform present and future plans.

Climate adaptation plans have the largest share of word frequencies for the code *adaptation*. This code is usually used to list measures intended to fight climate change and its repercussions. Regarding flood (one of the many consequences of climate change) climate adaptation is seen as a way to build up resilience. Climate adaptation is more mentioned in Danish documents because it is part of the branding of the city. The EU also aims at *forging a climate-resilient Europe (title)* by implementing sustainable growth strategies and facilitating the creation of knowledge on climate change across all MS. In Nice, climate adaptation is perceived through the lens of sustainable development.

5.1.1 Flood Risk Management Strategies in Studied Documents

While the results of the expert interviews and inductive coding account for the growing consideration of urban planning and flood prevention strategies, when looking at FRMSs absolute frequencies, the code *protection* is disproportionately visible in studied documents. In French documents, *recovery* (with rebuilding and insurance measures) is the most cited code while it is *flood prevention* for Copenhagen. This difference lies in how flood risk is addressed in both case studies and will be further explained in the following sections.

Assigned Code	Copenhagen-Denmark	Nice-France	EU	Total
Mitigation	12	7	51	70
Preparedness	29	137	77	243
Prevention	55	432	119	606
Protection	404	655	330	1389
Recovery (rebuilding OR insurance)	7	472	178	657

Table 3: Absolute frequencies of FRMSs codes

5.2 Deductive Coding

In order to fully grasp the data and to evaluate the spectrum of themes, deductive codes were performed in the research. Table 2 (p.41) is a summary of deductive codes found in studied plans. The most striking finding is the predominance of the code *quality of life* in climate adaptation and urban

planning plans in both cases. Nice and Copenhagen aspire to ensure high-quality built and natural environments by focusing on sustainable development.

Copenhagen "is paving the way for sustainable transformations in the existing city" (Københavns Kommune, 2015, p.25) by acknowledging its responsibility for the environment and future generations. This is promoted with the city's goal to become the world's first carbon-neutral capital by 2025 (Københavns Kommune, 2019). Three areas of interest were defined: housing, mobility, and sustainable infrastructure. Housing is concerned with the capacity to accommodate a growing population following the criteria of the dense city to avoid urban sprawl while soft mobility (bicycle and walking) is encouraged with adequate infrastructure. Sustainable infrastructures include sustainable urban drainage systems (SUDS) such as green roofs, green spaces to reduce flood risk and improve the sewer systems.

Nice intends to provide solutions to the three pillars (ecological, economic, social) of sustainable development by:

- preserving biodiversity and natural resources,
- ensuring social cohesion and solidarity between territories and generations,
- ensuring the quality of life of its inhabitants, and
- by boosting the development of the territory with eco-friendly production and consumption of goods and services (Urban Planning and Development Department, 2019b)

According to the PLUm, these objectives entail the development of adaptive practices in spatial planning and a long-term vision. As in Copenhagen, housing and mobility are pivotal urban elements to ensure sustainable development and quality of life by offering better public transit and a denser urban fabric with more housing opportunities.

The code *learning* (inductive coding) is not frequently quoted in the documents studied. Nevertheless, the stages of urban project coordination that include evaluation, monitoring, reporting, and meeting can be seen as learning episodes and are more commonly cited. The group of codes *evaluation OR monitoring OR report OR meeting* (from deductive coding) was therefore created to grasp learning practices in both case studies. Climate Adaptation plans and FRMPs are particularly concerned with projects' monitoring and follow-ups (i.e. reports and meetings) to ensure their implementation. In Copenhagen, the need for following up on the development of climate strategy was stated in the Capital Region Adaptation plan. In this regard, a Climate Forum was appointed to coordinate local and regional aspirations. The process of climate adaptation ought to be evaluated once a year. Conferences and seminars bringing experts, politicians, and professionals enable follow-ups. Similarly,

in France, the National Council for Sustainable Development (*Conseil national de la transition écologique*) is responsible for monitoring climate adaptation and ensuring annual follow-ups of the implementation of national climate adaptation strategies. This council is supported by regional committees and observatories that reinforce monitoring at a finer scale.

Regarding FRMPs, in France, PAPIs (Action Programme for Flood Prevention) intend to assess FRMSs by prioritizing operations; evaluating the implementation of projects according to the expected results and financial means; using monitoring and evaluation indicators; and having a mid-term review of the action programme (Ministry of Ecology, Sustainable Development, Transport and Housing, 2011, p.6). The Danish Cloudburst Management Plan (2012) states that putting its objectives into action is a long-term project and its operation is estimated within a minimum frame of 20 years. Monitoring and follow-ups for each water catchment are expected to assess the risk, the implementation of projects, their coherence with urban development projects, and synergistic effects (City of Copenhagen, 2012, p.15).

	Absolute Frequency									
Assigned Code	Copenhagen-Denmark				Nice-France				EU	TOTAL
	FRMP	CA	UP	Total	FRMP	CA	UP	Total	Total	
Adaptation	38	187	22	247	5	29	14	48	415	710
Collaboration OR Coordination OR Communication	10	72	15	97	71	38	39	148	369	614
Flood OR Rainfall OR Downpour OR Storm Surge	409	486	1	896	440	3	111	554	1322	2772
Learning	0	3	8	11	0	2	2	4	5	20
Resilience	5	0	7	12	21	25	7	53	89	154
Spatial planning OR urban planning OR development	112	343	1096	1551	108	68	1132	1308	250	3109
Vulnerability	5	50	1	56	264	9	71	344	39	439

Table 4: Absolute frequencies of assigned codes per case study- inductive coding

	Absolute Frequency									
Assigned Code	Copenhagen-Denmark				Nice-France				EU	Total
	FRMP	CA	UP	Total	FRMP	CA	UP	Total	Total	
Branding OR International Competition OR attractivity	0	32	43	75	0	8	44	52	203	330
Evaluation OR monitoring OR report OR meeting	8	33	8	49	110	70	624	804	272	1125
Governance	0	1	0	1	62	7	13	82	22	105
Integrated approach (sometimes holistic)	22	10	20	52	17	4	51	72	98	222
Housing	1	12	378	391	19	9	124	152	4	547
Mobility	0	5	9	14	16	21	111	148	1	163
Participation OR involvement OR consultation	4	16	28	48	20	15	33	68	183	299
Project	18	157	24	199	177	56	1047	1280	30	1509
Quality of Life	5	108	248	361	8413	2828	26255	37496	73	37930
Sustainable Development	30	137	441	608	126	146	1195	1467	277	2352

Table 5: Absolute frequencies of assigned codes per case study- deductive coding

5.3 Nice, France: Analysis of Findings

This subsection will now focus on Nice to evaluate how the Metropolitan Area of Nice addresses FRM, strategies on climate adaptation and urban planning, and actors' appraisal of FRe. Attention will particularly be paid to collaborative (coordination, cooperation, and collaboration) and learning practices.

5.3.1 Evolving Approach to Flood Resilience: The Virtuous Flood Risk Management Approach

The previous chapter revealed the importance of having a holistic approach in dealing with flood risk. In Nice, this approach is supplemented by a virtuous FRM which perceives risk as an asset rather than a hindrance. In the Metropolitan Urban Sustainable Development Plan, a list of measures is enumerated to ensure virtuous risk management, including the integration of risk management into urban projects, construction restrictions, and the development of urban agriculture (DGAALM, 2017). Respondents from Nice tended to believe that risk can be a positive opportunity to implement sustainable development:

> *"I don't think that a risk is a hindrance to development and even less so to sustainable development. For me, risks are one of the facets of the environment. If we take risks into account ahead of a flood, not only do we have a structure, a development that is much more resilient but also that will be able to adapt to various and varied changes, climatic or economic change ... it will work all the better because if we do not take risks into account, one day or another the risks catch up with us and this is when problems arise"* (interviewee 3, translation by the author).

It is important to note that in NCA's Metropolitan Master Plan (hereafter PLUm), FRM is the first driver of metropolitan resilience. Though resilience is not defined in the plan, it is legally carried out with the Flood Risk Prevention Plan (hereafter PPRi) superseding urban development. This legal framework agrees with a holistic approach as FRM is interpreted concomitantly with sustainable development to halt urban sprawl. Elements of spatial planning –mobility, housing, and quality of life– form components of this holistic approach that envisions the city as an integrated whole. The PAPI encourages and supports integrated projects compatible with national policies on FRM. PAPIs are organized around a pilot structure (e.g. steering committees) that is responsible for the application and approval phases of a project.

5.3.2 Operationalization of Flood Resilience through Flood Risk Management Strategies

When looking at the operationalization of FRe, I decided to adopt a chronological approach to evaluate operationalized measures before, during, and after a disaster respective of FRMSs. In the case of Nice, prevention (before flooding) became one of the main strategies to improve FRe. Yet, in France, according to Arnaud Gossement (interviewed on the TV experts' panel, see methodology), flood is still addressed in a curative approach with a lagging legal framework that still considers flooding from a recovery standpoint. Nice differs from this approach having implemented flood prevention plans (PPRi) since 2002. PPRis are very dependent upon political choices as a *préfet* (regional state representative) prescribes prevention plans to limit urbanization in flood-prone areas and control urban development in vulnerable to flooding zones. Measures are thus imposed on a defined perimeter of a city and follow a colour-coded zoning system which can be related to flood mitigation:

> *"There are zones that are not concerned with flood risk, zones highly vulnerable to flooding whereby we consider the risk to build to be too high, and intermediary zones or blue zones where flood risks are acceptable. In these zones we apply building conditions such as raising the second floor, not building on the entire parcel to make room for the water and then avoiding building incentive or strategic public safety facilities in our flood zones. In blue zones, we only accept housing or commercial activities or businesses but no sensitive buildings that accommodate vulnerable groups like young children, nurseries, kindergartens, and schools or adults in vulnerable situations, very old people or who have lost mobility"* (interviewee 2, translation by the author).

Prevention is made up of urban planning strategies, crisis management, and preventive information (public awareness). Spatial-Urban planning has gained recognition as a promising instrument to prevent flooding. The subtle differences between spatial and urban planning are overlooked here for simplification. Prevention is particularly successful when it is accompanied by mitigation strategies such as zoning (quote above). Combined, they can act as leverage to build up resilience. Acknowledging flood risk in development plans also provides a new framework for crisis management which is administered by the *Préfecture* (State's representative at the regional level). While floods are inevitable, institutions play an important role in raising public awareness. This contributes to creating a risk culture that relies on preventive information and the acculturation of society in the face of risks. The State is in charge of providing information and bringing public awareness. Sustainable development and the transmission of knowledge are now included in the national education system in light of the updated legislature on education.

Therefore, prevention also consists of public awareness and education. Respondents mentioned that public awareness is crucial to ensure the population's safety. In NCA, risk programmes were developed by elected officials and broadcast to the population to explain how to act during a disaster. These strategies necessitate intricate coordination between different levels of government involved in flood governance, in particular between the State and the territorial/local scales. In Nice, the Departmental Directorate of Territories and the Sea (DDTM) and the *préfecture* coordinate these strategies.

Following the chronology of flooding, during a crisis, FRMSs correspond to preparedness and response. They aim at guaranteeing safety with warning systems and disaster management. They are closely linked to prevention as actors are already collaborating and exchanging significant knowledge beforehand:

> *"In times of crisis, at the level of the COD (departmental operational centre), there is an executive from the Metropolitan Area who goes to the COD as requested by the préfet, which makes it possible to connect the Metropolitan and the Departmental services. So, we have this link at the level of the COD, a link in operational communication between the metropolitan headquarters and the city of Nice. With the other municipalities, we communicate beforehand in a preventive manner, exchange information by emails with each municipality. We draft a situation report and when we make a weather report for the Metropolitan Area, we distribute it across the territory" (*interviewee 3, translation by the author).

When a disaster arises, dialogue is favoured by already established connections between municipal/ metropolitan departments, with informal communication settings. Respondents agreed that knowing the different actors they have to deal with during a disaster facilitates the effective functioning of the response. Indeed, because of the potentially disastrous consequences of a flood, communication between different municipal, metropolitan departments, and other institutions (e.g. SMIAGE) is carried out daily. Meetings are set up 4 times a year to discuss flood risk and FRMSs, and to get to know fellow actors. This has resulted in the creation of a network. Moreover, the public is notified through a mass call system "Viappel".

> *"On the day of the crisis, when I have someone I know on the phone, it is much simpler and more direct than when I have someone I do not know*" (interviewee 3, translation by the author).

After a disaster, experience and restitution meetings piloted by the *Préfecture* are organized to discuss what went well and what could be improved. Respondent n°4 highlighted the importance to mention what went well as an action leverage for future flood risks. These meetings are conducted within the

framework of the PAPI by a steering committee composed of all actors involved in FRM, included the private sector and the public:

> *"PAPI is directed by a steering committee in which we find all the actors of the territory: the State and the different municipalities on which the PAPI intervenes and there is also the private sector, with for example network managers, associations, representatives of economic activities, environmental associations or residents. Only then- if I may say- is a network created, since there are progress reports, coordination, information, which are given to all these actors"* (interviewee 4, translation by the author).

Recovery is a crucial element of the post-disaster phase. In France, the Natural Disaster scheme *(arrêté Catastrophe Naturelle)* enforced in 1982, acknowledges the disaster which permits the recognition of the damages caused by it. This paves the way for people's right to insurance. According to Magali Reghezza (TV experts' panel, see methodology), insurance is seen as the best guarantee for FRe because insured people can afford to rebuild and recover from flooding. However, because of the frequency of floods in the Region of Nice, it was argued by respondents that reconstruction is not always possible. Arnaud Gossement (TV experts' panel) quoted the French President who declared that "we will not be able to rebuild everywhere, and what we are going to rebuild will be in a resilient and sustainable way".

5.3.3 The Role of Collaborative Practices

5.3.3.1 Collaboration and Communication in Flood Governance

In Nice, the PAPI states that there is a will to construct collaborative flood governance for flood prevention projects, established on consultation with stakeholders. In this context, consultation refers to the institutional participation of civil workers and experts coordinating FRMSs, and consultation with the public. Communication among stakeholders is crucial in FRM and is implemented on several scales. In NCA, communication between mayors of municipalities and the Metropolitan Area is enforced before a disaster.

As mentioned, public consultation is of paramount importance to create sustainable flood governance. Not only does it involve the local population but it also helps to exchange relevant information on exposure to flooding in urban zones. Yet, a major obstacle faced by institutions is the short-term vision of inhabitants who tend to forget about past floods and refuse to move out of at-risk zones. Respondents argued that the public has an active role in FRM, especially in the preventive phase as citizens can participate in public hearings and get acquainted with flood risk. This agrees with the French legal framework as all municipalities subject to natural risks must produce a municipal information document on major risks. Likewise, municipalities that have already experienced flooding

must create flood markers to remind the public of past events. These actions are dependent upon improved scientific knowledge and awareness-raising. According to the National Climate Adaptation Plan, preventive information, awareness-raising, and knowledge sharing help increase risk culture, especially by including the public, the private sector, and politicians. Indeed, the measure "knowledge and information" of the abovementioned plan provides ways to improve knowledge on climate change. According to the Local Strategy of Flood Risk Management (SLGRI), schools also participate in the development of risk culture with plans to educate students on major risks and conducting flood exercises. Similarly, the department of Alpes-Maritimes instigated Remembrance Day (October, 3rd) to bring awareness and educate the public on disasters and risks.

Figure 8: Traffic Sign in Nice, "risk of flooding in rainy weather" (author, 2021)

5.3.3.2 Coordination in Flood Governance

Coordination is threefold: with different stakeholders at different governmental scales (multi-scale governance), international coordination with the EU and supranational agreements (i.e. Paris Agreement), and coordination of the legal framework as plans must be in accordance with other legal documents.

In the Adaptation Preparedness Scoreboard document, the EU identified a major weakness in the French multi-level governance in the coordination between national policy and measures at the local level. Adaptation policies were based on the implementation of a coordination mechanism between levels of government resulting in a network of regional adaptation committees (Ministère de la

Transition Ecologique et Solidaire, 2018). On the local level, objective 5 of the Local Strategy of Flood Risk Management (SLGRI) intends to federate actors involved in the FRM of Nice-Cannes-Mandelieu La Napoule FRM (i.e. territory vulnerable to flooding). This objective is twofold: the introduction of the SMIAGE and the monitoring of the local strategy which is undertaken by the SMIAGE. Regional committees also promote communication between actors with information sharing.

As a global issue, climate adaptation is discussed in international agreements that impact national targets and laws. For instance, France has to implement climate adaptation strategies in line with the objectives of the Paris Agreement and other international conventions (Ministère de la Transition Ecologique et Solidaire, 2018). Within the framework of climate adaptation, regional adaptation guidelines are present in a myriad of plans namely the regional development plan, development, and territorial equality, regional climate, air, and energy plan (p.6). In terms of FRM, the PAPI specifies that one of its main goals is to promote a coordinated implementation of all the regulations related to flood prevention and management. The PAPI seeks to ensure better coordination between FRM prevention politics, urban development goals, and management of natural milieus as prescribed by the FD.

5.3.4 The Role of Learning Practices

5.3.4.1 Exploitation Learning: Past Experiences

The literature review has demonstrated that a flood event can give momentum to redefining flood risk measures. For instance, the SLGRI claimed that “On October 3, 2015, the Alpes-Maritimes department experienced a rare climatic event of exceptional violence. The disastrous outcomes of these floods, both human and material, have forced local actors to redefine risk prevention policies” (Préfecture of The Alpes-Maritimes, 2016, p.49). Exploitation learning (i.e. lessons learned from past experiences) is instrumental in rethinking risk prevention policies. According to the SLGRI, following the floods of 2015, the DREAL (Regional Department of the Environment, Planning and Housing), the Region of Provence Alpes Côte d’Azur (PACA), and the DDTM aspired to launch “characterization” as a novel method to assess flash floods and runoff risks. The method of characterization aims at improving knowledge on runoff risks, analyzing flash flood risks, and suggesting actions to improve FRM (Préfecture des Alpes-Maritimes, 2016, p.34). These measures call for coordination between stakeholders, but also between legal documents. The PAPI acts as a mediator between flood risk and urban planning plans especially with urban planning rules targeting urban runoffs.

The 2015-flood also led to a paradigm shift from a reactive approach to flood risk to a more proactive approach:

> *"let's say that all the actors of the territory realized that there was a need to act, so we reached a proactive approach that was carried out by everyone, the préfecture, the municipalities, everyone participated and this also led to the creation of the SMIAGE"* (interviewee 5, translation by the author)

Respondents tended to say that weather alerts are more efficient today as a result of new measures taken after 2015. The local population also learned to trust weather alerts and is more likely nowadays to follow recommendations:

> "*10 years ago, in this region, when there were weather warnings indicating when it would rain, people took their cars to leave the house and now they don't anymore; so we do learn from disasters*" (Magali Reghezza, translation by author).

Learning practices are thus present at several scales: at the institutional scale with new measures but also at the citizens' scale with risk awareness. This is supported by the creation of awareness programmes as a result of learnings from past disasters.

5.3.4.2 Exploration Learning: The Contribution of Climate Adaptation in Flood Risk Management Plans

Exploration learning consists of integrating adaptive measures having a long-term horizon. Future-oriented measures play a significant role in climate adaptation, which is concerned with sustainable development. According to the National Climate Adaptation plan, one main objective is to envision development practices in a long-term perspective without comprising the functioning of existing ecosystems. The plan considers long-term territorial dialogue within the legal framework to strengthen climate resilience. The PLUm follows the principle of sustainable development by targeting sustainable mobility and housing. The former is primarily focused on developing soft mobility infrastructure while the latter –housing—takes into consideration climate change impacts in housing constructions and heating systems.

Exploration learning can also be a result of consultation and collaboration among stakeholders. For instance, the State recognizes the role of public consultation to promote climate adaptation. In 2019, a national public consultation resulted in a bill entitled *"bill on combating climate change and strengthening resilience to its effects"*. As a result of a major national debate, the public demanded a participative democracy and a fairer ecological transition. 150 individuals were randomly chosen to participate in the drafting of this bill which focuses on building adaptive governance through measures dealing with consumption, production and workforce, mobility, housing, food, and a legal framework for the environment. Each theme was discussed by working groups composed of experts, and civil society.

Moreover, pilot projects emerge as leverage to foster sustainable development. The Metropolitan Area developed the eco-valley project discussed in the literature review. OIN Var Plain aspires to turn the valley into an "eco-valley" based upon sustainable development: land use, the reinforcement of green and blue infrastructure as a network, public transportation, the maintenance of ecosystems, and the creation of an urban park (Urban Planning and Development Department, 2019a).The OIN is thus an integrated development model on a territory of near 10,000 hectares (Urban Planning and Development Department, 2019a) which proposes to create major public facilities (3 million m² of building capacity) and employment (up to 50,000 new jobs) sustainably and compactly. Flood prevention was included in the premise of the project:

> "*What is interesting with Var Valley is the idea to be able to think with all the data we have on urban development including the risks, to have a global vision and to make it an asset. Risks are everywhere, but territories that take risks into account at the beginning of the project are not found everywhere*" (interviewee 3, translation by the author).

OIN Var Valley is viewed as a way to halt urban sprawl as compact development is favoured to avoid excessive consumption of land. OIN Var Valley is expected to be flood-resilient thanks to adaptive housing measures and green and blue infrastructure. PPRis cover most of the surface of the project and zoning was developed taking into consideration different flooding scenarios.

When looking at Nice's FRMSs, one can identify a shift towards flood prevention measures such as preventive information, public awareness, and flood risk consideration in new urban development project. Collaboration occurs through formal and informal communication at all stages of a flood event which help operates FRMSs. Yet, coordination between different levels of government with multi-level governance remains complex and could impede long-term changes.

Figure 9: Photos of Grand Arénas and Nice Méridia within the OIN (see map) (author, 2021)

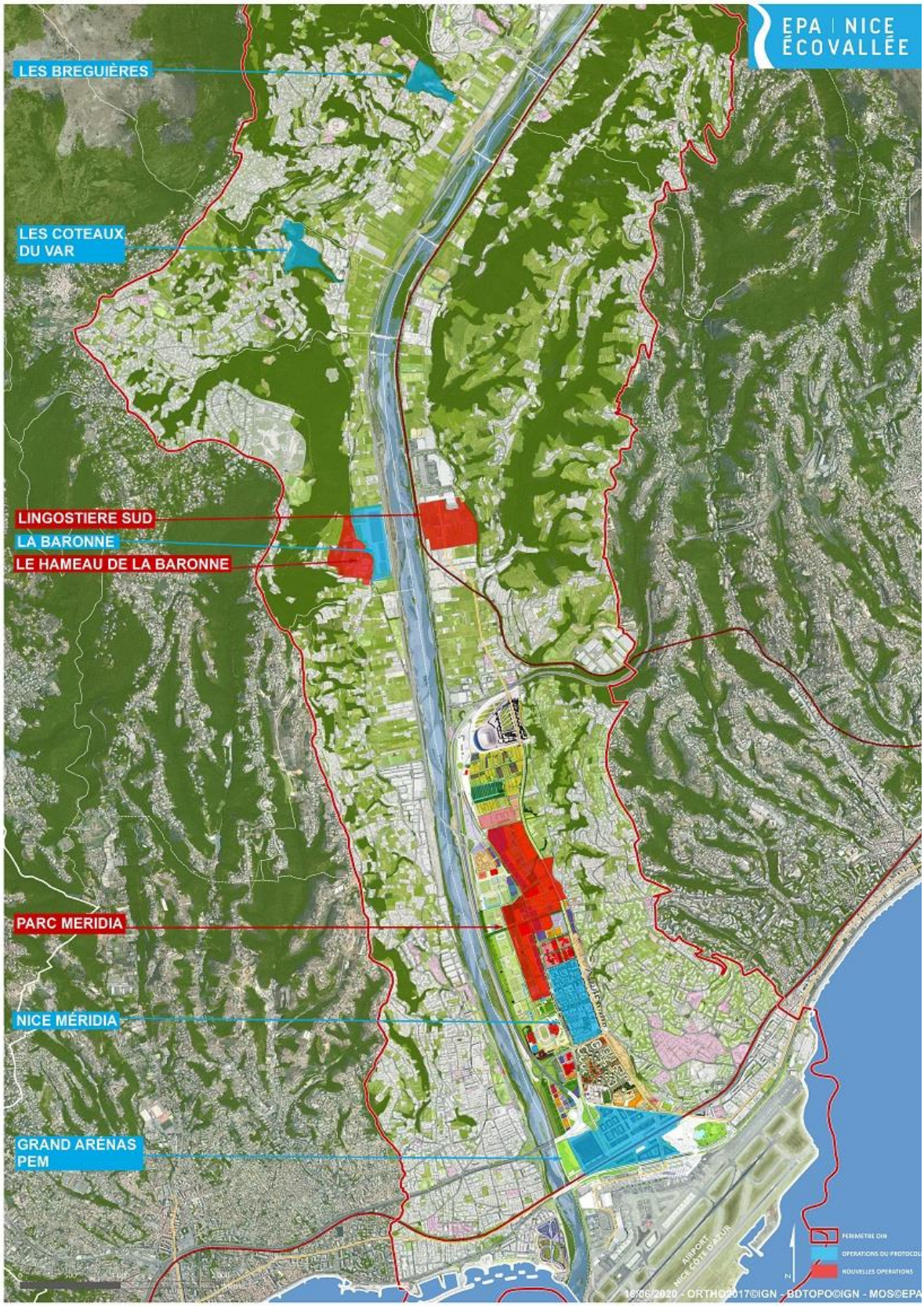


Figure 10: Map of the National Interest Operation, Nice Eco-Valley (Nice Eco-vallée, n.d., *retrieved from* http://www.ecovallee-plaineduvar.fr/les-projets)

5.4 Copenhagen, Denmark: Analysis of Findings

This subsection will discuss Copenhagen's approach to FRe. As for Nice, it also focuses on collaboration and learning(s), and their impact on the operationalization of FRe.

5.4.1 Evolving Approach to Flood Resilience: From a Reactive to a Proactive Approach to Flood Risk

To address flooding, Copenhagen uses a disaster cycle management approach which encompasses mitigation, planning and preparedness, response, and recovery. FRMSs and disaster cycle management include the same strategies (apart from protection and prevention). In Copenhagen, all parameters of FRMSs/ disaster cycle management are dealt with and aimed at facilitating the operationalization of FRe. This was enabled thanks to a paradigm shift from reactive to proactive FRM that happened in the aftermath of the last major flood episode in 2011.

> *"From our perspective and from the municipality's perspective, we were not prepared at all and the politicians were not proactive at all, they were more reactive"* (interviewee 6)

Respondents agreed that Copenhagen was caught unaware by the 2011 flood. As a result, the municipality has adopted a holistic approach to flood that is articulated in the studied documents. Interviewee 10 mentioned the need to develop a nexus planning across all sectors involved, including health, mobility, housing and water management in a comprehensive manner to achieve climate adaptation.

Copenhagen is at risk of extreme rainfall and storm surges. To deal with the former, the municipality has adopted two scenarios: the traditional solution which is a technical approach of water drainage based upon the extension of the sewage system. The management of heavy rainfalls is also approached through the lens of the "combined solution", which considers the combination of surface solutions (sewer-based solutions) and retaining/draining water (City of Copenhagen, 2014, p.5). These approaches are heavily reliant upon the construction of new infrastructures. Regarding storm surges, Copenhagen considered two solutions: the inner solution seeks to protect the harbour and quaysides of Nordhavn, Svanemøllen and the east coast of Amager by raising dikes in the harbour. The outer solution –chosen solution—is less invasive to the city as it ought to protect it by constructing barriers, dikes and floodgates North and South of the city (City of Copenhagen, 2017). Because of its exposure to flooding, the city of Copenhagen opts for structural (i.e. infrastructural) measures. These measures are part of a comprehensive approach to FRM and climate adaptation.

5.4.2 Operationalization of Flood Resilience through Flood Risk Management Strategies

The operationalization of FRMSs accounts for the degree of FRe of a city. As in Nice, FRMSs will be assessed in chronological order. Prior to a flood episode, monitoring and urban/spatial planning are the two main actions to resist flooding in the future. According to interviewee 10, climate adaptation and climate resilience are included in the development of new urban areas. Technical departments and companies ensure that new buildings and underground infrastructure can accommodate stormwater. However, sustainable development remains difficult to implement as the planning of the city is still path-dependent reproducing old development models:

> *"In Copenhagen, I still think that we are doing new urban development much in line with what has been done"* (interviewee 10).

During a flood, emergency plans are drafted and geared towards the municipality and the fire department. Respondents stated that during a crisis, there is a close collaboration between the municipality of Copenhagen, surrounding municipalities and fire departments. The communication in times of crisis is favoured by informal network with civil workers who already know each other:

> "*I would say that the communication is rather informal based on personal connections. We are in close communication with the fire department and Copenhagen to ensure that the population knows what is happening and is safe."* (interviewee 9)

Additionally, the public is notified by formal means of communication such as text messages, emergency notice through the radio, the TV, and press release. Public consultation occurs before a flood episode:

> *"Right now, the public is not involved in what to do when a flood happens but we have the Risk Management Plan that is sent out to the public so they can read it (before a flood event) … so that they can respond to it and tell us what they like and dislike."* (interviewee 5)

During a flood, information is channelled to the public and undertaken by the communication department whose main goal is to broadcast information. Within the institution, the crisis and emergency coordinator writes emergency plans for internal use in the municipalities as they are not publicly available. Emergency plans are tools for civil workers to know how to react to flooding.

Copenhagen is currently drafting a flood risk management plan that addresses the aftermath of flooding as floods can have long-term repercussions.

> *"We deal with the aftermath because this is a crisis happening now but it is also a crisis that stretches forward for months possibly years. We have just started making a plan for that period. And that plan is a flood risk management plan. There is a new one coming up soon and states that the municipality will work on a rebuilding (recovery) plan, what to do and what we expect within 6 months after a flood."* (interviewee 5)

While all parts of the disaster cycle management are taken into account, respondents state that the municipality has been focusing on prevention and preparedness strategies and is now appraising flood recovery plans.

5.4.3 The Role of Collaborative Practices

5.4.3.1 Collaboration and Communication in Flood Governance

In Copenhagen, strong multi-level and cross-municipality collaboration is intended to contribute to creating a greener and climate-resilient environment. This is also facilitated by interaction between the private and public sectors which work together to find solutions to fight climate change while enhancing the city's attractiveness with competitiveness of industry and improved quality of life.

Copenhagen is concerned with stimulating an open dialogue with its residents to discuss the city's needs and potentials (Københavns Kommune, 2015). The Danish government frequently organizes open hearings and consultations in drafting adaptation policies, such as a National Dialogue Forum in 2012 connecting research institutions, the private sector, and municipalities. In 2017, the public was involved in coastal adaptation initiatives (European Commission, 2018b).The public is systematically involved in the monitoring, evaluation and review of national adaptations measures (European Commission, 2018b). The main idea under the title "Co-Create Copenhagen" is to foster change through an intricate collaboration between the municipality and private actors (residents and companies). To build a greener city, "the process must be less controlled – it must unleash Copenhageners' creativity so that everybody works together to build the city we want" (City of Copenhagen, 2015, p.2).

Communication between different departments of the municipalities and neighbouring municipalities is conducted daily:

> *"Because we are only responsible for the response there are no formal synergies per se but informal ones with urban planning and other departments. The communication with other relevant departments is daily. They tell us about new projects or construction works to upkeep the roads".* (interviewee 9)

Collaborative practices necessitate a multi-level governance structure that is composed of two types of governance: on the one hand, at the municipal level amongst different department offices, and on the other hand, across regional levels of government from the national to the local scales. Both encounter difficulties occurring as a result of different risk perceptions, expertise and professional background.

> *"We also have to share that knowledge with the rest of the municipality, that could be a challenge sometimes because we have different professions and risk perceptions*" (interviewee 5).

Moreover, inter-sectorial and interdisciplinary collaborations across different sectors at different levels of government are still difficult to implement nowadays:

> *"We'll have to have collaborations (…) but I would say that this is an aim, but to realize it, it's quite difficult*" (interviewee 10).

5.4.3.2 Coordination in Flood Governance

Legal coordination is crucial to ensure the successfulness of flood governance and climate adaptation. In Denmark, the Environmental Protection Agency and the Ministry of the Environment and Food are responsible "for coordinating integration of adaptation into legislation" (European Commission, 2018, p.8). These institutions are supported by inter-ministerial coordination groups whose aim is to coordinate adaptation policies across levels of government. On the regional scale, the capital regional climate adaptation plan stipulates that cross-municipal coordinated strategies should be implemented by neighbouring municipalities and municipal utility companies. Copenhagen's Climate Adaptation Plan echoes this notion as Copenhagen and neighbouring municipalities have cooperated to have wastewater planning and municipal water management plans.

Regarding FRM, the EU asserted that climate change concerns were incorporated into flood maps and most FRMPs point out municipal climate adaptation/ mitigation plans. Yet, the EU affirmed that the coordination between plans is not clearly expressed especially between national climate adaptation strategies and municipal FRMPs. Copenhagen's Climate Adaptation Plan stresses the importance of cooperation between the municipality and research institutions to find innovative solutions to climate adaptation and FRM. Studies are conducted to find ways to have a greener and bluer city geared towards protecting the city from heat waves (i.e. another climatic event). This agrees with the Regional Growth and Development Strategy which states: "Hence, the Capital Region of Denmark, in cooperation with local authorities, businesses and knowledge institutions, will take the lead in efforts

to ensure climate adaptation in Greater Copenhagen to protect residents and companies' investments" (Centre for Regional Development, 2016, p.28).

Another way to create cooperation is by initiating cross-disciplinary network such as "Water in Cities" integrating views from universities, public and private institutions. Flood protection and sustainable development networks have blossomed within the framework of Copenhagen's climate adaptation plan to deal with rising sea level, urban drainage systems, green urban design and climate-reliant buildings (City of Copenhagen, 2011). This corresponds to what was said by respondent 10 who played an active part of developing the national network for climate adaptation which aims at introducing nature-based solutions as part as FRMSs.

The municipality of Copenhagen wants to ensure coordination of climate adaptation and green city measures so as to maximize the benefits of new green infrastructures such as green wedges and corridors. The Mayor of the Technical and Environmental Administration acknowledges in the Preface of the Cloudburst Management Plan (2012) that coordinated actions result in making Copenhagen "a safe place to live and to invest in" (p.2).

5.4.4 The Role of Learning Practices

5.4.4.1 Exploitation Learning: Past Experiences

As in Nice, exploitation learning from past experiences has led to a paradigm shift from reactive to proactive FRM.

> *"I would say we are quite proactive. I mean, this is an on-going process and I think the 2011 flooding was really a huge provocation that really started this kind of planning in Copenhagen. At that time, some of the very important infrastructures were actually quite threatened by rainfalls. So, I think there was a great emphasis on "this should not happen again". And a lot of measures have been taken on, but also integrating FRe"* (interviewee 10).

New infrastructures were constructed in the aftermath of the 2011-flood in order to separate stormwater from wastewater. There is a current debate in Copenhagen about building an artificial island that would act to protect the city from flooding but also respond to a growing population.

In order to prevent the 2011 flooding from happening again, flood risk was included in urban regeneration projects. Respondents mentioned that new (pilot) projects forge Copenhagen's resilience to flooding. In Copenhagen, the first climate-resilient neighbourhood (Sankt Kjelds district) was erected in Østerbro as an urban regeneration project (see figure 11 p.58). According to interviewee 10, Sankt Kjelds district was started as an urban regeneration project that would develop

the identity of the neighbourhood by having a participatory process. The 2011 flood created a political momentum as new concerns about flooding arose, and redefined the purpose of the project as developing the first climate-resilient neighbourhood of Copenhagen. Green nature-based solutions were implemented to deal with stormwater while public consultation was concerned with the local identity of the neighbourhood in a climate-resilient fashion. However, respondent 10 mentioned that the project remained a top-down professional approach imposing plans on the residents.

5.4.4.2 Exploration Learning: The Contribution of Climate Adaptation in Flood Risk Management Plans

Copenhagen is known for being one of the world's most sustainable and eco-friendly cities. According to Copenhagen's Co-Create Plan, the city "will be the world's first carbon neutral capital city" by 2025 (p.14). Copenhagen aspires to become a world leader in climate adaptation and a "living showcase" (City of Copenhagen, 2015, p.1).

Regarding sustainable development, the Co-Create Copenhagen Plan alludes to the will to ensure current liveability without compromising future generations, and reminds its reader that citizens, the private sector and municipalities have a common responsibility for the environment: "We want Copenhagen to be a more robust, resilient city, ready to cope with the climate of the future" (p.14). In Copenhagen, climate adaptation is at the intersection of exploitation and exploration learnings as it utilizes "the latest knowledge and technology [and, it] is also adapted to development in society" (City of Copenhagen, 2011, p.6). Green solutions have arisen as "tools for reducing and preventing stormwater floods and ensuring that we continue to have an agreeable climate and diverse urban nature" (City of Copenhagen, 2011, p.57). Climate adaptation and FRM go hand and hand as Copenhagen focuses primarily on the management of stormwater and recreational uses around waterbodies. Recreational areas are expected to improve residents' quality of life by providing areas where they can partake in leisure activities while making the city climate adaptive for the future. Multi-uses water basins were constructed in flood-prone areas of the city. They are not, however, unanimously accepted as mentioned by one interviewee:

> "*The new big thing is that the city builds these plastic football pitches. And* [*they can be used*] *as cloudbursts basins as well. So, it's like a marriage of convenience, the cloudburst basins that are not being prioritized as such, are football pitches. But they are very unpopular locally because* [*they are made of*] *plastic and they are loud and destroy nature"* (interviewee 8).

Combining recreational use and flood-proof infrastructure is Copenhagen's preferred option. However, interviewee 8 signalled that while Copenhagen aspires to become a greener city, some areas where water basins are erected are made of plastic and concrete. The Cloudburst Management Plan

states that pluvial flooding adaptive measures would ideally make Copenhagen greener and bluer thanks to water drainage systems. Underground infrastructures (i.e. tunnels) ought to be constructed in places where ground level solutions are not possible. The former solution –on ground level—is preferred as its outcomes are twofold: a flood-resilient city by releasing pressure in sewage systems and a greener city with green and blue infrastructure on ground level. Plans from Copenhagen tend to direct all efforts towards green solutions, however in practice adaptive measures are subject to political will and require a more flexible management. Indeed, interviewee 8 mentioned that engineering companies who are in charge of developing green solutions are often composed of civil engineers who undertake underground/tunnel projects. When conducting ground level projects, engineering companies tend to overlook environmental issues that are more complex on the ground. As part of his job (see methodology), interviewee 8 seeks green ground level solutions but is confronted to political decisions that favour concrete underground infrastructure:

> *"So, we have a green cloudburst plan in Copenhagen, but it's really not being implemented. Most of the investment goes to huge concrete tunnels underground"* (interviewee 8)

Building a greener city is included in climate adaptation measures where quality of life is paramount. The municipality aspires to make Copenhagen more liveable by arranging urban spaces so as to "accommodate a greater number of everyday activities" (i.e. multi-uses water basins) a safe and integrated city around mobility, workplace, recreational areas, and cultural amenities (City of Copenhagen, 2015, p.6).

Figure 11: St. Kjeld's Neighbourhood, Copenhagen's first climate-resilient district (The Next Green Website, n.d., retrieved from http://thenextgreen.ca/2017/05/31/st-kjelds-neighbourhood/)

5.5 Flood Resilience as a Result of a Holistic Approach

5.5.1 Attitudes towards the capacities of Flood Resilience

Overall, the respondents supported the findings from the deductive results as a holistic approach (sometimes referred to as "a nexus planning") needs to be promoted, considering FRe in regards to urban development and climate change (see table 6 p.60). Although resilience is still fairly abstract, its operationalization is visible –to some extent– with FRMSs.

As a reminder, resilience is rooted in the capacities to resist, absorb, recover, adapt and transform (Driessen et al., 2018; Fournier et al., 2016). The main difference between the case studies lies in the appraisal of FRe capacities. The capacity to resist is often linked to resistance-like structural measures including dikes, dams, water retentions increasing an urban area's flood protection. Flood protection is still the most frequently used term in climate adaptation, flood risk management, and urban planning plans across studied documents. In Copenhagen, *protection* appears 404 times across studied documents as the municipality has undertaken construction works to become more flood-resistant within the outer solution to protect the city from storm surges. In NCA, dams are located throughout the metropolitan region to resist flooding. The capacity to absorb and recover entails the absorption of disturbances by flood-prone areas, and flood preparation and recovery strategies (Hegger et al., 2016). As discussed earlier, France's FRM is still set on a curative approach which explains the significance of the use of the terms like "recovery", "rebuilding", and "insurance". Prevention is also frequently used, suggesting that it is becoming increasingly important which is corroborated with the increase of flood prevention investments especially in pilot projects (PAPI). As Copenhagen was more focused on flood prevention and preparedness in the aftermath of the 2011-flood, its capacity to recover is only being assessed now with the drafting of the first recovery plan. It is noteworthy to state here that the capacity to transform is not yet visible in plans (in both case studies) as FRe is still at the stage of incremental adaptations which might lead to societal transformations in the future.

In both case studies, a holistic approach is therefore praised by respondents who tended to agree that breaking with existing thinking siloes and merging urban functionalities in an integrated approach can lead to FRe:

> *"The search for resilience, in my opinion, is based on the crossing of functionalities, for example water retention basins, which are used very little for their retention function, can be leisure parks for the rest of the time"* (interviewee 2, Nice, translation by the author).

Interviewee 7 (from Copenhagen) emphasized that to make a city sustainable and resilient, institutions should step away from siloes since climate change also impacts drought, heatwaves, rising sea levels. To "decompartmentalize" them, an ideal scenario would allow the city to store excess water underground to keep the city moist during episodes of drought and heat events as evaporating water is considered the most efficient and sustainable way to cool down a city.

Assigned Code	Absolute Frequency	Assigned Code	Absolute Frequency
Climate Adaptation	16	Governance	13
Sustainable Development	8	Learning and Collaborative Practices	4
Economics-finances	6	Legal Framework	7
Flood Risk Management	4	Lagging legal framework	17
Aftermath of a flood episode	10	Mismatch between political agenda and FRM	8
Holistic Approach	9	Resilience	18
Momentum of a flood	8	Urban Planning	31
Project-led Approach	12	An integrated city	2
Recovery	5	Infrastructure	9
Shift from flood protection to flood risk management	2	Positive Opportunity	3
Follow-up and Implementation	2	Risks	7

Table 6: Codes from Interviews

However, interviewees also warned against the risk of replicating solutions from elsewhere that cannot be applied in another territory. Different types of floods warrant for different types of governance and underlying communication and coordination strategies. There is no one-fits-all model and differences lay in the magnitude and velocity of flooding. In Nice flash floods are particularly violent and fast because of its Mediterranean climate.

> *"Although there are common traits, every place has its own peculiarities because, simply the conditions are not the same everywhere…Every place has a different situation to respond to and that's why it's important to make flood risk assessment"* (interviewee 1, EU).

5.5.2 The role of the Floods Directive (FD) (from the EU)

The EU has a pivotal role in promoting (transnational) learning and collaboration. The Common Implementation Strategy (CIS) serves as a collaborative platform and facilitates the exchange of experiences and best practices namely on how to communicate progress in the implementation of the strategies in light of the FD. The CIS allows Member States (MS) and the EU Commission to operate and coordinate at the national level, as the FD does not interact directly with municipalities because of resource constraints. In *Forging a Climate-resilient Europe*, it is mentioned that the EU is willing to learn from experiences across MS and share knowledge using the platform Copernicus (EU's Earth Observation Programme). The EU promotes both exploitation and exploration learnings by facilitating

knowledge exchange on adaptation and wicked problems. Yet, the supranational level of government recognizes significant knowledge gaps and the need for more knowledge in developing innovative approaches.

The FD has requested MS to endorse a three-step cyclical approach to FRM since its implementation in 2007: by the end of 2011, MS were expected to have undertaken preliminary flood risk assessments (to identify flood-prone areas); draw flood hazard maps by 2013, and draft FRMPs by 2015. The publication of FRMPs is a requirement under the Directive and they must be used as management tools to reduce the potential adverse repercussions of extreme flooding.

The CIS also gives recommendations to the MS by exploring areas for further development. According to interviewee 1 (EU), MS participate in the CIS voluntarily, which enables good communication between the supranational and national levels of government. Discussion may arise for the Directive –like other EU directives— has a clause of reporting which is mandatory. Reporting refers to passing information from one source to another and is cost and time consuming:

> *"So, one challenge is to come to an agreement on how much information needs to be passed from the national level to the EU level, put in simple and correct terms"* (interviewee 1, EU).

The Directive gives general recommendations applicable throughout all MS, and country-specific guidelines. Overall, the Directive incites the MS to have active involvement of all stakeholders throughout the process of FRMPs (drafting, reviewing, and updating). Having an overarching view of FRMSs from the EU creates discrepancies among countries. According to interviewee 6, in Denmark: *"We are a lot of steps ahead of EU requirements right now, we are taking it even more seriously that's why we handle (FRM) ourselves this time!".*

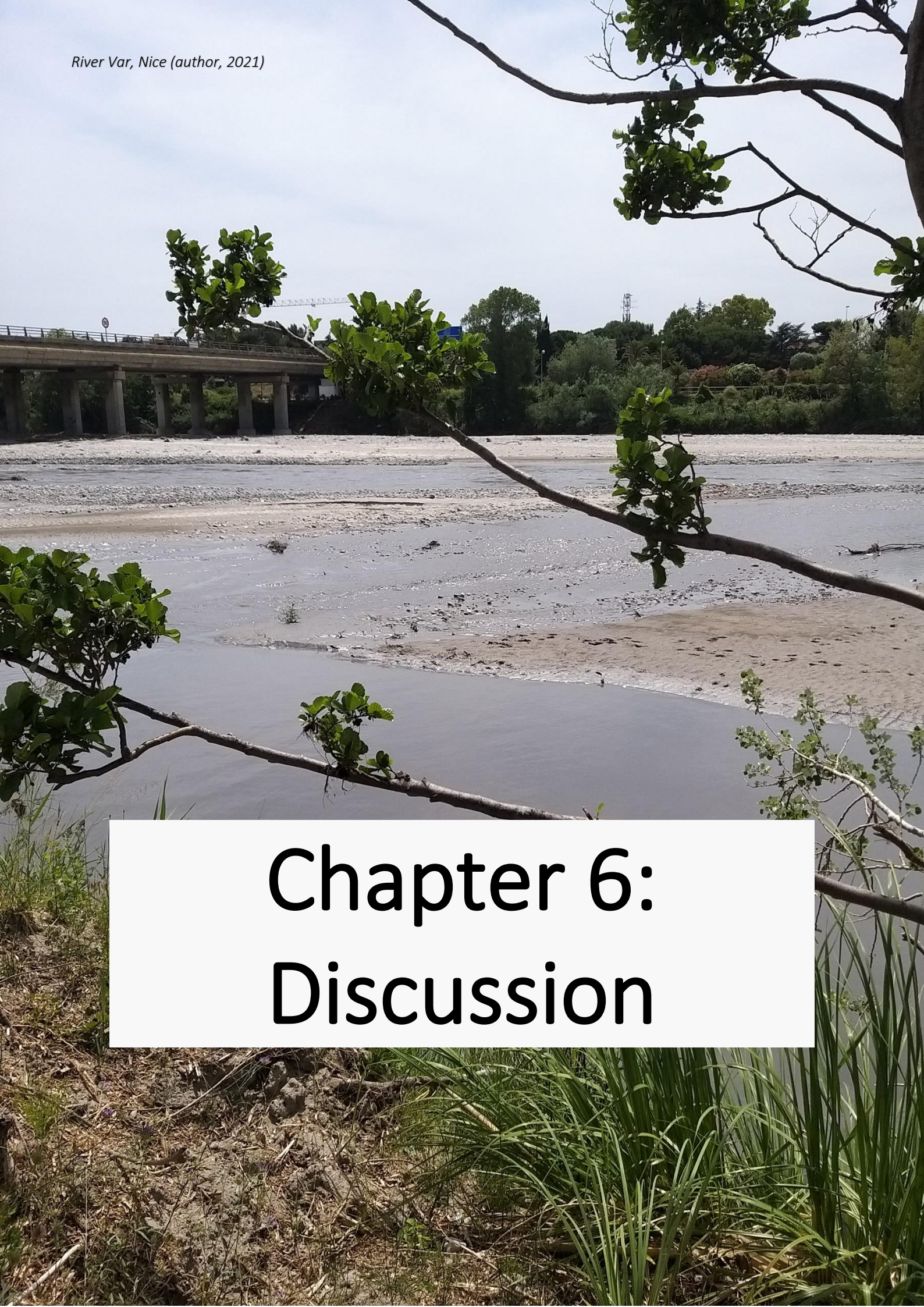
For Denmark, while climate adaptation is mentioned in FRMPs, "there is no apparent coordination between the FRMPs and the national climate change adaptation strategy"(European Commission, 2019a, p.13). The EU recommends that coordination between the two is clarified in FRMPs. The FD therefore demands clarity on how climate mitigation and adaptation plans impact FRM measures in Denmark. Regarding FRMPs, the FD advises Denmark to provide information on the process of FRMPs development and on the costs and funding sources for the measures undertaken. Further information is also asked on the prioritization of measures and the monitoring of the implementation of measures. France is advised to ensure transparency, especially in international river basin district instances by providing more information on international coordination efforts (European Commission, 2019b). Operational monitoring is expected to be improved by including all water bodies prone to flooding. Recommendations for France also consist of a thorough assessment of potential projects in

accordance with the Water Framework Directive. Emphasis is put on the consideration of restoration measures and green infrastructure and/or natural water retention structural measures to have greater environmental, social, and economic benefits than with grey infrastructure.

MS can also benefit from financial support from EU funds to launch climate/flood resilient projects and interregional projects (INTERREG). According to the EU's Adaptation preparedness scoreboard on France, the state relied on the European Structural and Investment Funds to finance climate resilience and risk management strategies to up to €4,866m (European Commission, 2018a). Denmark uses a co-financing method to invest in climate change strategies. The Capital Region, municipalities, the state, and private actors fund climate adaptation (City of Copenhagen, 2011).

5.6 Conclusion

After evaluating the results of these two cities, it has been shown that the operationalization of FRe is still difficult to implement because of the complexity of flood risk and the complex structure of a multi-level governance. The following chapter will further discuss these aspects of FRe, and identify key barriers to change.



River Var, Nice (author, 2021)

Chapter 6: Discussion

6.1 Comments on Flood and Current Trends

This chapter weaves together the abovementioned findings by relating them to theory. The literature review has demonstrated that socio-ecological resilience –which considers non-structural measures– has gained importance in climate adaptation and FRM debates. It is axiomatic that flood resistance (structural and technical measures) enhances a city's FRe, but it is not a lasting solution. However, flood resistance measures still dominate resilience formation efforts as flood protection is described as the way to go. One can argue that flood protection can be seen as an enhancer of FRe but not as an end in itself. The framework of socio-ecological resilience helps to broaden the scope of solutions by focusing on human interactions and governance. Yet, although collaboration and learning practices are critical to forge FRe, there remain institutional obstacles such as path dependency, lack of resources, or personal behaviours.

The empirical data corroborate some of the findings from the secondary data, such as the need for a holistic approach of FRM. Flood-related strategies can be vehicles for a more inclusive and integrated perspective, whereby interdisciplinarity is a priority. Studied plans in both cases praise a holistic approach to ensure on the one hand quality of life, and sustainable development; and on the other hand, climate change and FRe. Similarly, an integrated flood management assumes and enables flexibility in the decision-process, where learning is seen as intrinsically sought after from past experience and future-oriented strategies (McFadden et al., 2009). Flexibility also leads to creating an adaptive governance as flexible arrangements facilitate coordination and ongoing interactions between actors (van Buuren et al., 2015). According to McFadden et al. (2009), such an integrated management "also requires building a memory of past events, abandoning the notion of stability, and increasing the capacity to learn from crises" (p.638). Both case studies include a memory of past events in their strategy whereby recent floods triggered novel adaptive measures. In Nice, after the 2015-flood, a Remembrance Day on October 3rd was enacted. This event is used as an instance of public awareness, where the population is taught about climate change, risks (not only flooding but also drought and forest fires) and adaptations. In Copenhagen, the Storm Surges Plan (2017) identifies the storm surge of 1872 as the most recent significant storm, and observes that in the Køge Harbour (South of Copenhagen), water marks are still visible on buildings as showcases of how high the water had risen (p.17). According to Hallin et al. (2021), this storm is still remembered nowadays and helps raise awareness locally and regionally.

6.2 Approaches to Resilience and its Difficult Operationalization

This chapter means to provide answers to the research question and to its supporting questions. Each question will be stated and will have an assigned sub-section. The main research question is: **How do learning and collaborative practices contribute to the operationalization of flood resilience in urban planning and climate adaptation plans in Nice and Copenhagen?**

Perceptions of resilience are vast, somewhat abstract, and often inconsistent. In academia, the inconsistency in definitions (with more than 70 different definitions of resilience) does not permit one to have a clear basis on which to build FRMSs (Mcclymont et al., 2020). Flawed conceptualization of FRe can lead to inadequate FRM and hinders the operationalization of FRe. Operationalizing resilience thus implies resilience management which is associated with a shift from theory to policies and then to practices (Naderpajouh et al., 2018). In practice, resilience also has different meanings for different individuals. The difference lies in the understanding of resilience and the political will of the institution in place: the more eco-responsible the political party, the more likely climate change will be addressed together with FRe.

In regard to collaborative practices, interviewees tended to agree that resilience requires collaboration and coordination that are still difficult to implement. This was accounted for by differences in risk perception, urgency of uncertainties, and governance obstacles. Therefore, the path to the operationalization of FRe involves multiple actors, organizations that adhere to different sets of values, norms, practices which inevitably create divergent logics and conflicts (Naderpajouh et al., 2018).

When assessing the operationalization of FRe through FRMSs, it became clear that cities should diversify their flood related portfolio as prescribed by Driessen et al.(2018) or Hegger et al. (2016). Both cities are currently expanding their portfolio in the opposite direction of each other: Copenhagen which used to heavily focus on preparedness strategies, now directs its attention towards recovery plans. On the other hand, flood strategies in Nice were set on a curative approach driven by recovery measures and are now prevention-oriented.

6.3 Spatial Planning and Flood Risk Management

This leads us to explore one sub-question: **How much of flood related issues/FRe is included in broad urban development plans?**

Results have demonstrated that flood-related issues are only sporadically mentioned in urban development plans. Interviews on the other hand revealed that civil workers give a preponderant place to flood prevention strategies, from which new perspectives of spatial planning arise. Flood risk maps that identify vulnerable areas are a first link between spatial planning and flood risk. In both cases, they are also communication tools provided to a myriad of actors such as firefighters, first respondents, different departments within an administration, and to the public. The diversification of FRMSs with the increased involvement of spatial planning can lead to synergies between the two disciplines and the creation of integrated water management (Meng et al., 2020). When looking at the state of the art of FRe and new directions for spatial planning, Meng et al. (2020) found out that the literature on FRe can be broken down into four distinct pillars: environmental, disaster management, socio-economic, and institutional/governance. The authors argued that spatial planning research and practitioners tend to focus mostly on disaster management concerns omitting the other pillars. This contradicts some findings, for environmental and socio-economic concerns are weaved together with disaster management to have climate/flood resilience, along with a sustainable city emphasizing the quality of life.

In addition to flood prevention, the integration of water in spatial planning plans and projects creates an attractive urban landscape, especially with tourist or recreational amenities, and the protection of biodiversity. The underlying aim is to have an integrated and well-connected city, with high quality of life and flood/climate resilience. This echoes a significant finding of this work: the code *Integrated approach* was found 222 times (52 in Copenhagen, 72 in Nice, and 98 in EU documents). Two takeaways emerged: the EU recommends addressing climate adaptation and FRe having an "integrated city", and both cities strive to implement those recommendations. Moreover, climate adaptation and FRe push actors of urban development to build on the long term, which has led to projects with the integration and management of water and nature in urban areas.

> While FRM is only occasionally stated in planning documents, there is evidence of attempts to connect and weave together urban issues (mobility, housing, and quality of life) and FRe (through climate adaptation).

6.4 Learnings

This subsection explores the following supporting question: **How important is learning in achieving FRe?** The answer to this question will be divided into two parts: taking into consideration past events and lessons learned in decision-making processes (exploitation), and the emergence of pilot projects in the aftermath of flood episodes as exploration learning practices.

6.4.1 Exploitation Learning: Learning from Past Experience and Lessons Learned

Learning goes hand in hand with collaborative practices, namely communication. Developing a risk culture seems to be an entry point to creating communications between the ruling institutions and the public. Better communication practices ensure that upon receiving information, the public behaves in such a way as to reduce and mitigate risks (O'Sullivan et al., 2012). In both cases, preventive information is accessible to the public which contributes to building risk culture. Yet, it requires a mutual engagement of parties involved which can be problematic as risk information is heavily dependent upon individual perception of risk. For instance, in NCA, residents tend to minimize current flood risks, forget about past events, and wish to move back where their house was flooded. This refers to the importance of raising disaster awareness.

Exploitation learning also implies having a historic standpoint on FRM. Interviewees tend to think that citizens have a growing role in forging FRe. When looking at lessons learned from past floods, one can think of enhancing society's memory of flooding. Having a historic standpoint on flood information not only creates a database to better comprehend the disaster but also contributes to the improvement of FRMSs especially through the development of a risk culture and risk awareness (Lang et al., 2010).

O'Sullivan et al. (2012) surveyed the perception of risk amongst "resilience groupings" that were asked to self-assess their levels of awareness, preparedness, and worry in European cities. The authors suggested that participants are inclined to leave the responsibility for FRM to the authorities, rather than taking responsibility for their own risk and their role in building FRe. This hinders good communication and reduces resilience. Public acceptance of its proactive role in FRM accompanied by incentives to promote information and risk awareness may enhance FRe. For instance, participants who think that it is important to be acquainted with preparatory information and pre-flood communications, tend to be in the high resilience group (O'Sullivan et al., 2012). Communication is therefore a critical component of flood prevention (beforehand), and preparedness and response

(during a flood). Results have shown that the authorities of Nice and Copenhagen are doing their utmost to communicate with the public through press releases, text messages, notices on the radio/TV.

Learning also favours adaptability, which is the ability to continue to adjust FRM and adapt to a changing flood regime (Kuang & Liao, 2020, p.3). According to Kuang & Liao (2020), experience incites learning and instructs flood management actions in all FRMSs. However, translating acquired knowledge about flooding into flood management is prone to facing lack of information and resource, reluctance to change, and policy barriers. The demanding task of transfer of knowledge was mentioned by interviewee 6 (Copenhagen):

> *"Also sharing maps has been an issue, when it is not happening, it is important to know what will be hit, what the stakes are, because we can block roads and stuff like that in advance ... But we don't necessarily have the same maps for instance between the municipality and the fire department because they don't always share maps with each other".*

Learning practices can be facilitated by pilot projects by favouring knowledge production and various types of involvement that enable learnings. For instance, Skt. Kjeld's neighbourhood (Copenhagen) which will be discussed in the following subsection, is now known as Copenhagen's first climate-resilient neighbourhood and was developed as a response to some of its location parts being completely flooded during the heavy rainfall of 2011 (Kjaer, 2015). In Nice, the numerous shock events of 1994, 1995 and 2014-2015 led to the establishment of the Eco-valley which is a demonstration neighbourhood for sustainable development in a flood-prone area.

6.4.2 Exploration Learning: Pilot Projects as prototypes of Interdisciplinarity in Urban Issues

The pilot project approach has emerged as a key aspect of operationalizing FRe and appears as a good practical instance of including flood risk in spatial planning as well as learning practices. Pilot projects are prototyping the current trend of interdisciplinary as they are at the crossroads of engineering, urban planning, and risk management. Interviewees highlighted the importance of pilot projects to foster climate adaptation, sustainability and urban regeneration. They can also enable flexibility and adaptability in climate adaptation measures, being part of a larger urban setting, such as an urban regeneration project. As trials, pilot projects are experimental in nature and have the potential to bring people together. Pilot projects also enable actors to have a holistic approach to FRM.

In Copenhagen, the Cloudburst Management Plan (CMP) set seven water/surface runoff catchments, with sub-areas referred to as "cloudburst branches" which outline the flow paths of rainfall-runoffs

(Lerer et al., 2017). More than 350 interventions were implemented in the seven catchments for a budget of EUR 1.3 billion, ranging from retention spaces, cloudburst boulevards, green streets and roofs, and cloudburst tunnels (Ziersen et al., 2017).

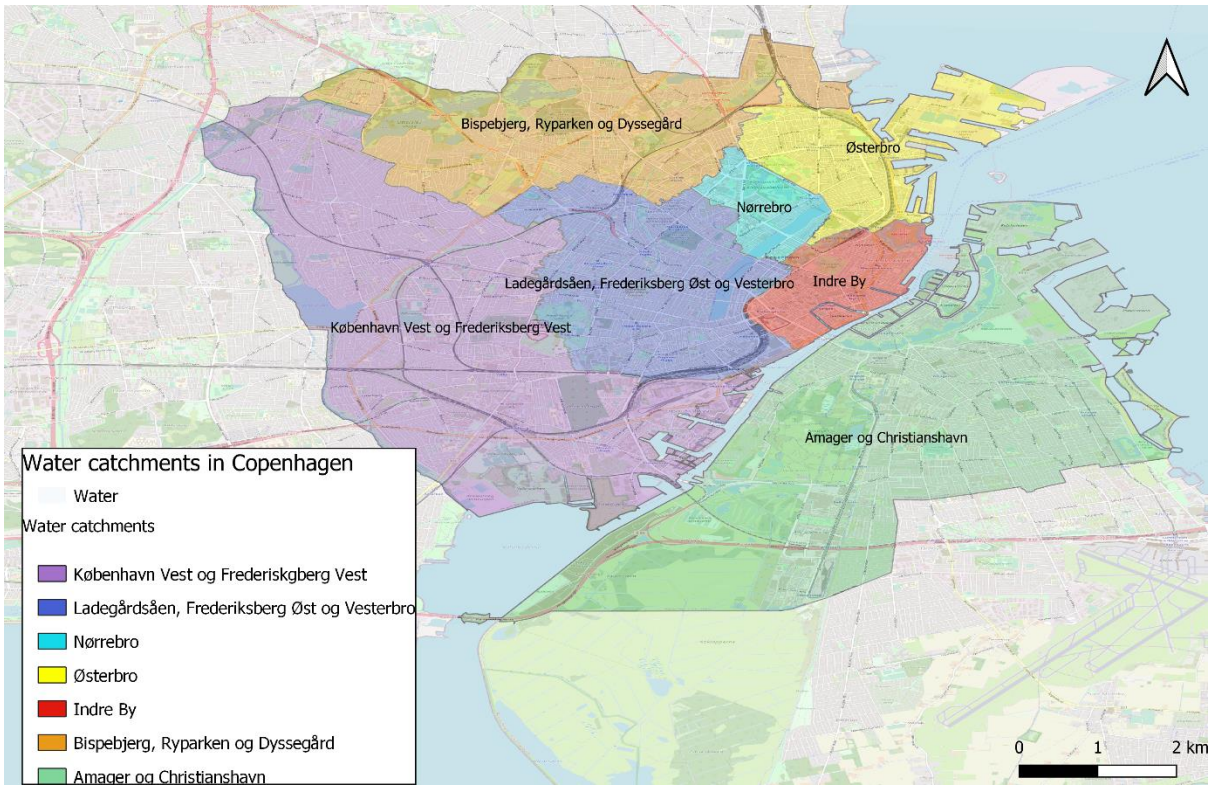


Figure 12: Copenhagen's seven water catchments (map by the author, 2021, using QGIS)

"Ydre Østerbro" is one cloudburst branch located in Østerbro (North-East of Copenhagen) and is the first climate resilient neighbourhood of the capital. "Ydre Østerbro" is part of a pilot project whose main goal was to implement climate actions within the framework of the Climate Adaptation Plan concomitantly with an ongoing urban regeneration project in the Sankt Kjelds neighbourhood. The urban regeneration project was concerned with improving housing, public space, and outdoor recreation amenities.

According to interviewee 10, the 2011-flood prompted the redefinition of the urban renewal project into an urban regeneration and climate-resilient project. Indeed, pluvial flooding necessitates great storage systems with "large amounts of safe-to-submerse space" that are multifunctional (Rosenzweig et al., 2018, p.12). Multifunctional areas that are new green public spaces are also intended to be used as recreational areas to motivate residents to use public spaces. These infrastructures can be associated with Blue-Green Infrastructure (BGI). In light of climate change, BGI can involve new design standards that are adaptive to projected occurrence of heavy rainfalls and is supported by the 3PA discussed in the literature review (B. R. Rosenzweig et al., 2018). Yet, to be successful, these new urban designs ought to be approved by the public who is expected to use them on a daily basis. While public

participation was a key element of Copenhagen's first climate-resilient district as the public was involved in both the urban regeneration and climate adaptation aspects of it, more punctual constructions of water basins (i.e. football pitches) do not always cater to the needs and wants of the local population (interviewee 8).

Kjaer (2015) mentioned that climate adaptation can create positive side effects and added value, but it cannot tackle all urban issues at once. Interviewee 10 (Copenhagen) highlighted that because of the very regulated and planned aspect of water management, its monetary resources and investment cannot be used to address other urban issues namely climate mitigation and livability as they "*do not work well together"*. To address them in a more holistic approach, interviewee 10 recommended the creation of new planning practices where interdisciplinarity is the cornerstone. Interdisciplinary is seen nowadays as a highly political term, as disciplinary knowledge (separated knowledge by disciplines) showed limitations in solving current issues such as wicked problems (Schmidt, 2007). Interdisciplinary also implies the creation of a new knowledge production in this competitive international context. Schmidt (2007) categorized interdisciplinarity into four types: epistemological that focuses on theories and concepts; methodological (the ways to produce knowledge); ontological (emphasis on objects and entities); and problem-oriented interdisciplinarity revolving around the problem framing and its underlying perception(s). Following this approach, one may argue that forging FRe is situated at the intersection of these types of interdisciplinarity as it warrants emphasis on flood events (the object), an improved theoretical framework (i.e. definitions of FRe), problem-framing, and finally, enhanced and innovative ways to produce knowledge. Thus, Copenhagen's first climate-resilient neighbourhood revealed how collaboration among the City, the Copenhagen Metropolitan Area utility (HOFOR), and the public (through public information and consultation) can be instrumental in including climate adaptation measures in a residential neighbourhood. While in Skt. Kjeld's neighbourhood (which is also a demonstration neighbourhood) sustainability was not one of the main concerns of the project, in Nice sustainability and sustainable development are chief preoccupations of the Eco-Valley project.

The project is situated along the River Var, and its tributaries *Estéron, Vésubie and Tinée* which can be particularly dangerous. This area is thus subject to flood risk which has not been taken into consideration in spatial planning for almost 150 years (Reghezza et al., 2012). In 1994 and 1996, floods occurred because the dikes along the river were insufficiently calibrated and breached. This confirms the need to acknowledge the fact that infrastructure can become obsolete and a diversification of FRMSs is required. According to Reghezza et al. (2012), uncontrolled urban development exacerbated the area's vulnerability to flooding. These events sparked discussion and, in the beginning of 2000, the

DTA (*Directive Territoirale d'Aménagement* -Territorial Planning Directive) was created to align several urban challenges, such as urban and economic development in a flood-prone area. In 2007, the National Interest Operation (OIN) was launched upon request of the local authorities to transform this discarded area into the heart of the metropolis (Reghezza et al., 2012). The concept of the so-called eco-valley (neologism) is built on a paradox: the development of a riverbank that concentrates flooding risks (fluvial flooding and rainfalls) and branding NCA as an area of environmental demonstration of regional and national know-how in sustainability management. This led to criticism from local organizations as mentioned in chapter 2. The economic purpose of the site seems to prevail, with cultural and economic amenities such as a shopping mall. Building a so-called Eco-Valley which is intended to be sustainable conceals the goal to brand the city, where "resilience" is used as a buzzword to attract investors and developers rather than a way to build a more resilient city.

In both cases, climate adaptation is used as a way to brand the city: Copenhagen aspires to become the first carbon neutral capital by 2025 while Nice strives to become an international showcase of environmental-friendly development with the Eco-valley. In the latter, the risk factor was included in the planning policy but does not appear as an objective as such, it is rather seen as an opportunity to further the development of the flood-prone area. The project lacks transparency and provides limited information (Larrue et al., 2016).

Both exploitation and exploration learning practices are crucial to forge FRe. Local authorities assessed past floods to learn so as to avoid repeating the same mistakes. Pilot projects are prototypes of exploration learning with future-oriented goals.

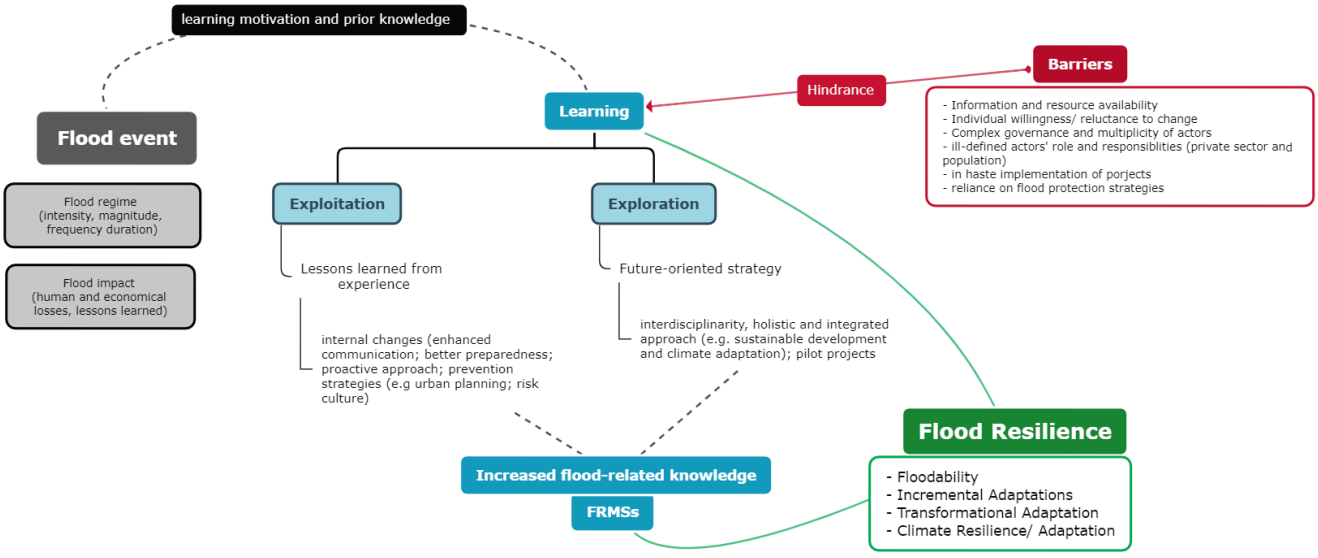


Figure 13: Learning From Flood (LFF) model, adapted from Kuang & Liao (2020)

6.5 Impacts of Flood Events

This subsection refers to the third supporting question: **Are flood episodes isolated catalysts for governance change or can they trigger sustainable systemic transformations?**

In this section, I intend to analyze the impacts of floods on governance, by breaking it down into two parts based upon the types of floods discussed in the work: first, heavy downpours in the example of Copenhagen in July 2011 and Nice in 2015, and then coastal flooding with Storm Xynthia in France (2010).

Copenhagen's most intense rainfall (July 2011) occurred a few weeks before the adoption of the city's climate adaptation plan. This experience proved that the initial plans dealing with heavy downpours were inadequate. In response to this event, the Cloudburst Management Plan brought together the municipality of Copenhagen and the Municipality of Frederiksberg and was released in 2012. The local authorities were thus able to use this momentum to redefine and adjust measures. Consequently, the cloudburst floods led to transformational measures with immediate and sustained adjustments in stormwater management practices (B. Rosenzweig et al., 2019). They also led to rethinking ways to approach flooding through the development of innovative infrastructure and the first climate-resilient neighbourhood. However, interviewee 8 alluded to the fact that the Cloudburst Management Plan was based on very imprecise calculations made in haste, which led to the development of more concrete infrastructure rather than the ambitioned green spaces. In regard to learning, the 2011 rainfall led to institutional learning, as great attention was paid to learning from this experience.

In Nice, according to interviewee 5, the 2015 flood event was a catalyst to redefining water governance bringing together local, metropolitan, and national actors (through the *préfecture*) which then led to the creation of the SMIAGE. It is a key player in the regional water and flood governance by virtue of its hydrometeorological expertise, communication with the public, and as a PAPI facilitator. The SMIAGE aims to improve structural and non-structural measures for its main objectives are: taking into consideration flood risk in land use planning, improving the forecasting of hydrometeorological phenomena and crisis management, restoring protective infrastructures (dikes), improving perception and risk culture, and federating actors of FRM (*Qui Sommes-Nous ? - SMIAGE*, n.d.). The floods of 2015 also triggered internal changes in flood risk governance with enhanced communication on forecasting flood events and communication with the public (interviewee 3). The case of NCA is at the crossroads of institutional learning (lessons learned from past experience) and social learning, with enhanced dialogue and communication (i.e. collaborative practices).

In regard to coastal flooding, in France the 2010, Storm Xynthia (*Tempête Xynthia)* was a catalyst for legal and governance transformation at the national and local scales. Interviewees from the experts' panel evoked Storm Xynthia as a milestone in shifting the approach to flooding with new policies such as new restrictions for residential areas. Storm Xynthia occurred on the Vendée coast causing damages on 1 176 houses (Ministère de la Transition écologique, 2020). This example is used here because its consequences had considerable impacts on the French legal framework and led to discussion on FRe. In the aftermath of this Storm, 330 coastal risk prevention plans were implemented (abid, 2020). One can argue that Storm Xynthia is an instance of policy learning with the enactment of the Rapid Submersion Plan focusing on prevention, preparation, protection measures to protect citizens and goods from coastal flooding (Larrue et al., 2016). National policy expanded incrementally with raising public awareness and acknowledgement of the limited role of the national state in FRM (Larrue et al., 2016). The National Rapid Submersion Plan's main objectives are: "(the) 1) "control of urbanization and adaptation of buildings in risk areas; 2) improvement of monitoring, forecasting, vigilance and warning systems; 3) improvement of the reliability of protection structures and systems; 4) improvement of the population's risk culture" (Quenault, 2015, p.9).

According to Quenault (2015), resilience became a praxis in the aftermath of Storm Xynthia as it questioned the urban development policies on the French coastline. The political injunction of "resilience" promoted a new risk culture and redefined roles within flood governance: State disengagement giving more responsibility to local actors and self-organization of civilians in the recovery phase (Quenault, 2015). This example is also a showcase of the problem of scales and the underlying tensions on FRMSs: on the one hand, the promotion of a more localized FRM that considers the specificities of one territory, and on the other hand, the legislative control of the State that is reluctant to delegate power to local authorities. This echoes what interviewee 2 (France) said about flood governance: The State's reluctance to delegate its power is explained by the fear that local interests supersede national ones namely FRM.

"it is important to underline the legislator considered that the risks were such a serious subject that it was better to keep risk management at the level of the State ... because sometimes at the level of the municipalities, the locally elected officials can be taken by local interests" (Interviewee 3, translated by author)

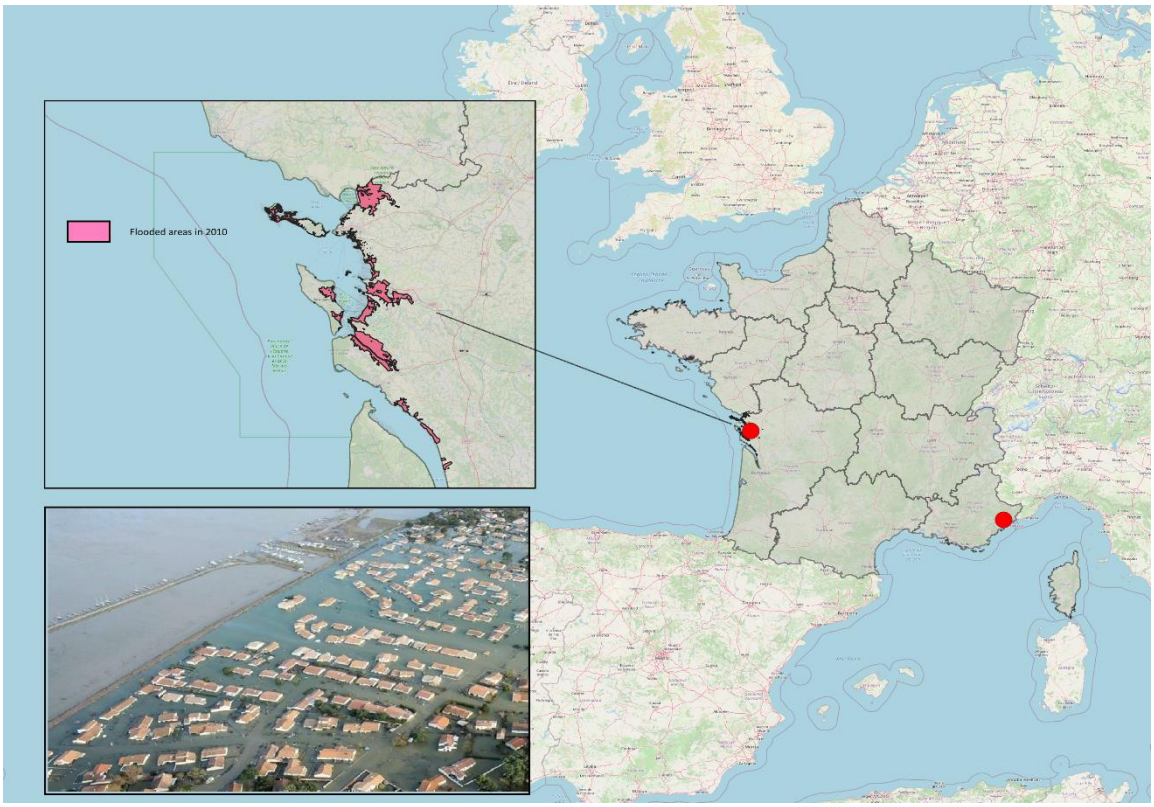


Figure 14: Flooded areas after Storm Xynthia, map by the author and picture of La Faute-sur-Mer Municipality particularly impacted by the storm (©archives Journal des Sables, (Journal des Sables, n.d., retrieved from https://actu.fr/societe/xynthia-47-morts-degats-considerables-dix-ans-tempete-endeuillait-france_31740900.html)

Flooding can have numerous impacts: new measures to become more flood resilient in the future, more suitable legal framework, better understanding of flood events, and governance adjustments thanks to enhanced communication and collaboration.

6.6 Institutional Barriers to Forge Flood Resilience

6.6.1 The difficult task of having collaborative governance

This thesis found out that the main hindrance to FRe is the lack of collaborative governance. While both cities have been striving towards achieving this goal, gaps are visible in the degree of public participation, the creation of a risk culture, and the often-ambiguous role of the private sector. As mentioned earlier, dealing with flood risk necessitates intricate collaboration between water professionals, other professionals often in the private sector, and the population.

In both cases, attempts to include the public in FRM, although quite limited, seem to illustrate the urge to have mutual collaborations within flood governance. For instance, due to its coastal location, Copenhagen is also subject to storm surges, potentially causing damages to properties. Landowners themselves are expected to ensure their safety by contributing to the financing and investing in sandbags. Madsen et al. (2019) argued that the involvement of the public (through the handing out of sandbags) participates in the municipality's resilience-building. Yet, interviewees tended to think that FRM remains a top-down approach as it warrants expertise.

In France, PAPIs stipulate that enhanced knowledge on FRM and risk awareness should go hand in hand. However, Reghezza et al. (2012) argued that PAPIs encourage a narrative that is contrary to risk awareness as the risk culture is engineering-oriented, hazard-focused since structural measures are adopted to mitigate and resist the risk. This also hinders public awareness and population's adaptation to the risk.

6.6.2 Specificities to the case studies

6.6.2.1 Nice, France

The main barrier in Nice is the multiplicity of the legal provisions and stakeholders involved. This element was found in both the primary and secondary data collection. According to Arnaud Gossement (interviewed on the TV experts' panel), "*we have a problem of overlapping competences between the préfet, the mayor, the notaries, in short everyone has a role to play in this matter and the problem is that it is does not necessarily work well".* The complex nature of flood governance–administrative organization–in France exacerbates the complexity of flood risk.

Reghezza et al. (2012) asserted that the multiplicity of legal tools has led to a piling up of measures creating a more complex and not very readable foundation on which it is difficult to base plans. The authors added that legal provisions are applied to Var Valley but are not necessarily connected with one another, which could lead to measures that are noxious to the environment. Arnaud Gossement (interviewed on the TV experts' panel) added that if the political discourse has evolved in environmental matters, the legal framework is still lagging behind because the law in France tends to reduce the share of environmental concerns to the benefit of the economy, exacerbating the contradictory interests of environmental protection and economic development. The multiplicity of the legal tools also hinders the adoption of a holistic and interdisciplinary approach, which is a prerequisite to forge FRe.

6.6.2.2 Copenhagen, Denmark

Copenhagen is renowned for its advance in sustainability, collaborative governance, and was accredited the European Green Capital in 2014. According to Alkhani (2020), cities have a pivotal role in addressing climate change challenges but are faced by two key obstacles: on the one hand, the ambiguous role of the private sector and underlying collaborative practices involved in building sustainable cities. On the other hand, the lack of consistency in assessing its involvement in government-led projects. Copenhagen displays a strong reliance on private companies' involvement in climate adaptation which is supported by the public authority (Alkhani, 2020). Utility companies are publicly funded but act as private companies seeking profit. Since 2013, water utilities such as HOFOR can finance surface solutions through taxes and are responsible for the overview of below and above ground hydrologic and hydraulic water systems (Ziersen et al., 2017).

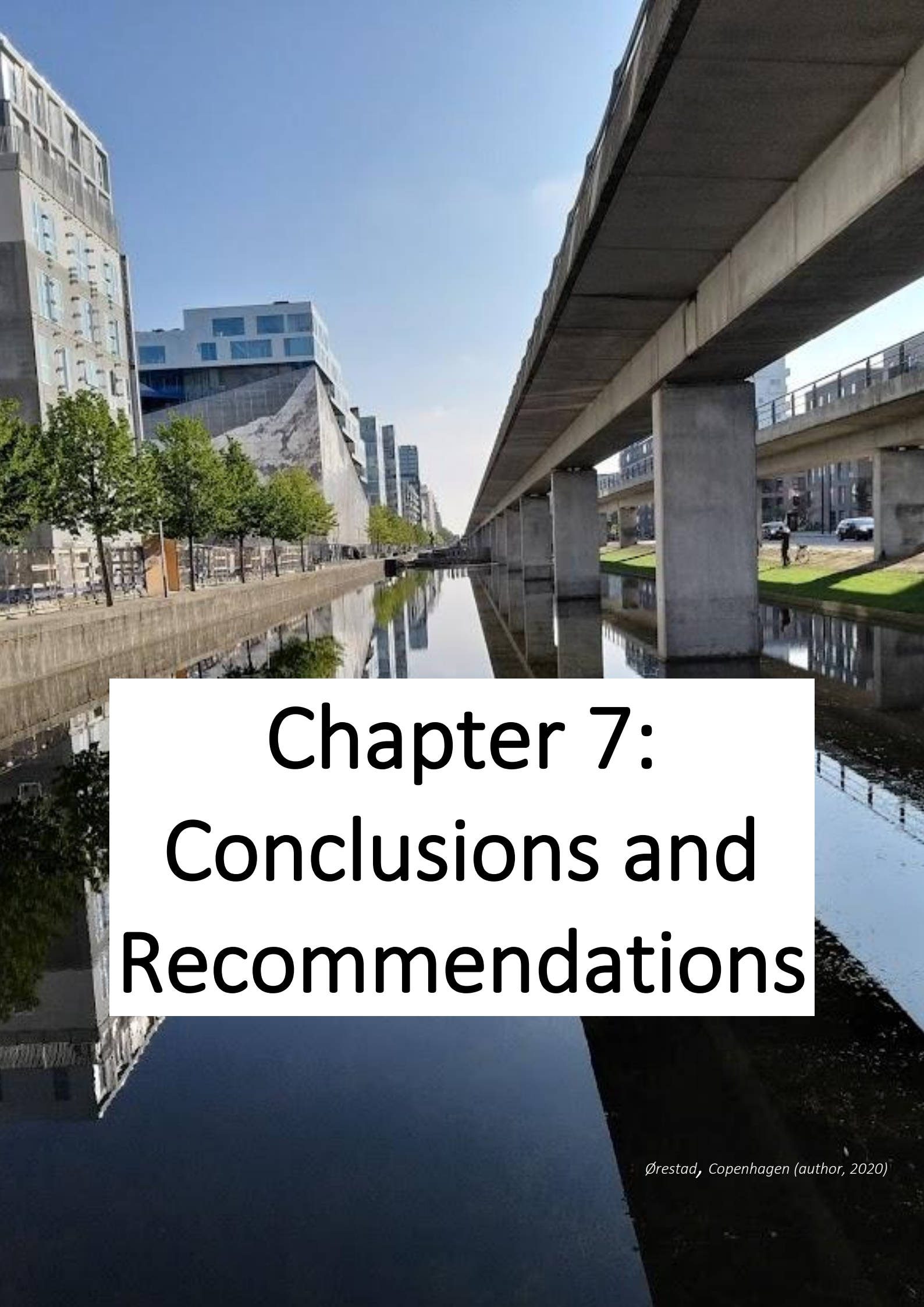
According to interviewee 8 (Copenhagen), engineering companies involved in the design phase of cloudburst projects have tremendous financial resources and tend to design unrealistic plans, which often end up being *"big concrete pipes because all the other plans didn't work".* Interviewee 8 added that companies are likely to come up with very complex ideas to profit from them, instead of developing the simple solutions that are known to work. Interviewee 10 (Copenhagen) expanded on this idea and mentioned that a prominent national barrier is that utility companies are regulating in a business logic whereby companies are expected to "*do everything cheaper and cheaper", which* in her view impedes innovation. Moreover, since they are business-oriented, they implement short term fixes based upon short term economic measures. Interviewee 10 asserted that long-term resilience and sustainability require the opposite approach according to which politicians recognize that "*utilities should have the space to actually work with innovation and long-term investments".*

This echoes the ongoing tension between long-term and short-term goals, punctual fixes (i.e., reactionary resilient measures). Climate adaptation and FRe are still at the stage of incremental adaptation that refers to a series of adjustments rather than big societal changes, anchored in a transformational adaptation agenda. According to interviewee 8, the development of waterproof structure (i.e. water basins) goes too fast as he mentioned "*we should probably take more time to find the right solutions for sustainable solutions".* He added that while the overall cloudburst plan gained momentum and was necessary to build up resilience, its implementation through physical actions is still ineffective.

While efforts are visible to forge FRe, path dependency, complex governance with the multiplicity of actors involved (especially the population and the private sector), the tensions between short term fixes and long-term goals impede its operationalization.

6.7 Conclusion

In this discussion, we have seen that the operationalization of FRe faces multiple obstacles, namely due to its abstract definition and conceptualization. However, in Nice and Copenhagen, there are efforts to forge FRe through collaboration and learning practices. The impacts of flooding on governance and the legal framework were stated. Finally, based on the two case studies, a list of institutional barriers was provided to identify better practices.



Chapter 7: Conclusions and Recommendations

Ørestad, Copenhagen (author, 2020)

7.1 Answering the Research Question

This chapter revisits the preceding chapters by summarizing their key findings and answering the overarching research question. This research aimed at assessing the role of learning and collaborative practices in forging and operationalizing FRe. The literature has proven that the concept of socio-ecological resilience is relevant here as it goes beyond the broad understanding of resilience. According to Zevenbergen et al. (2020), it is founded on:

- **The acceptance of imperfect knowledge altered by uncertainties, and hence no one-fits-all model or 'best solution'.** Results have shown that risks may well be a hindrance to urban development but can nevertheless be valuable assets as in pilot projects (Eco-valley and Skt. Kjeld's neighbourhood).
- **A long-term vision favouring learning and monitoring with incremental adaptations (short-term fixes) coupled with the capacity to transform (long-term changes).** FRe is considered to be reactionary to a shock and results in short-term fixes aimed at bouncing back to the initial state prior to the shock. Learning loops generate (and are generated by) these short-term fixes or incremental adaptations, which can ultimately lead to transformability. The case studies are showcases of coupling long term agendas (especially in urban planning documents) with incremental adaptations to ensure climate/flood resilience (e.g. the shift towards a holistic approach to FRMSs, enhanced communication, proactive FRM). However, they are also the showcases of the tension that arises between long-term agendas and shorter-term fixes such as fast implementation of measures in response to shock events conflicting with climate adaptation or sustainable development goals.
- **A holistic approach taking into consideration all aspects of flooding (FRMSs).** A diversification of the FRMSs of both case studies is visible. Indeed, Copenhagen that tended to focus on prevention and preparedness strategies is now more focused on recovery. Nice that traditionally addressed urban issues separately, has now adopted a virtuous approach on FRM mainly focused on having an integrated and holistic approach.
- **The willingness to facilitate participation and mutual learning:** FRe calls for developing adaptive governance with clear allotment of responsibilities and collaboration. To this end, establishing a risk culture (very visible in Nice, not so much in Copenhagen) through preventive information and awareness, helps include the public in FRe. Societies ought to learn to live with floods and play an important role in flood mitigation and adaptation.

The case studies demonstrate that there is a tendency to have a socio-ecological approach to FRe. While structural measures are still highly utilized, non-structural strategies emerged recently. The results thus indicate that the operationalization of FRe is favoured by collaboration and both exploitation and exploration learnings. Although learning practices are visible in both cases with the implementation of new measures in the aftermath of a flood event (exploitation) and future-oriented strategies (exploration), collaboration is still problematic. Several obstacles were found to impede collaborative practices namely the multiplicity of actors, their different risk perceptions, and the inadequate role of the population and the private sector. A summary of stability and change factors is given in table 5 (p.82).

7.2 Reflecting on the Completion of the Thesis Objectives

As stated in the introduction, this study entailed four objectives:

- The objective to compare FRe approaches in two European cities was only partially met as a thorough comparison was somewhat ambitious. The nature, the severity and magnitude of floods are drastically different in Nice and Copenhagen. The uncertainty revolving around sea level rising does not impact the cases in the same way. However, some understanding of the impacts of recent flooding in both cities was provided to comprehend how institutions react to floods.
- The objective to identify the role of collaborative and learning practices in the operationalization of FRe was met although a more hands-on, immersive procedure (i.e. taking part in FRM related meetings) would have been beneficial to fully grasp the extent of collaboration and learning.
- The objective to understand the connections between FRM and urban planning was reached as FRMPs, urban planning and development plans were thoroughly analyzed concomitantly. However, had time allowed, additional interviews with urban planners involved in the abovementioned pilot projects would have provided a more thorough understanding of the linkages between FRM and urban planning.
- The diagnosis of institutional obstacles hindering changes was provided thanks to extensive literature and expert interviews.

7.3 Recommendations

7.3.1 For Practitioners

This study is yet another argument to step away from existing thinking siloes which still rely upon resistance-based approaches by facilitating socio-ecological resilience. While it became clear that there is no 'best solution' in addressing FRe, some paths seem to lead to 'better practices':

- clearly defining resilience and the authorities' understanding of it;
- favouring innovative practices through ambitious plans and goals;
- adopting a holistic approach to FRe and addressing the temporality of the operationalization of FRe to build adaptive governance;
- including exploration and exploitation learnings along with collaboration; and
- developing a risk culture.

7.3.2 For Academics and Future Works

This thesis mainly focuses on top-down approaches to FRe by shedding new light on the importance of enabling learning and collaborative practices in ruling institutions of Nice and Copenhagen. Future research can complement this approach by taking the opposite standpoint and looking at bottom-up initiatives forging FRe. A strictly top-down structure leaves little room for engagement (beyond information and consultation) which prevents feedback processes and thus effective exploitation learning. Additionally, as a Eurocentric study, it overlooks solutions coming from the Global South mainly examples of bottom-up and community resilience. Analyzing mutual learning and focusing on the role of exploration and exploitation learnings through collaboration in the South is expected to contribute largely to the literature. Additionally, when looking at flood governance, analyzing the impact of innovative instances of public-private collaborations might distil insights on the importance of an integrated approach of governance. For instance, the 2020 floods in the region of Nice sparked original collaborations between artists, singers, athletes, and the *department of Alpes-Maritimes* (level of government between national and local) that strengthened public awareness and risk culture.

	Factors of stability		*Drivers of Change*	
Nice	Internal	External	Internal	External
	- Dense legal framework - Multiplicity of actors involved - Path dependency with significant investments in defense strategies (embarkments for the Var and Paillon) (Larrue et al., 2016)	- Centralization and FRM fragmentation (institutional and legal) (Larrue et al., 2016) - National curative approach (recovery) - Power and liability of the State (Prefect/ Mayor) - Abstract national understanding of FRe - Ongoing tension between short- and long-term fixes	- Virtuous FRM approach - Holistic and integrated approach (linked to sustainable development) - Eco-valley pilot project: Innovative coalition of State and local authorities - Enhanced communication during a crisis (within administration and to the public) - Creation of the SMIAGE (flood governance) - Risk culture (preventive information and awareness) - Learnings (exploitation and exploration)	- Shock events triggering emphasis on flood prevention (proactive approach) - Decentralization: new governance with empowerment of metropolitan/ regional bodies) (Larrue et al., 2016)
Copenhagen	Internal	External	Internal	External
	- Path-dependent development - Siloed thinking and significant reliance on concrete infrastructure (sewage and tunnels)	- Unclear role of and reliance on the private sector and the population - Ongoing tension between short- and long-term fixes	- Proactive approach (preparedness) - Holistic and integrated approach (linked to sustainable development) - Climate-resilient neighbourhood: innovative approach on urban regeneration and climate resilience - Emphasis of recovery strategies - Enhanced communication during a crisis (within administration and to the public) - Learnings (exploitation and exploration) - 3PA approach (Fratini et al., 2012)	- Shock events sparking new measures and redefining the legal framework - Agenda: First Carbon-neutral Capital by 2025 - Copenhagen's endorsement of competencies usually endorsed by the county.

Table 7: Stability and Change Factors for both case studies

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Promenade des Anglais , Nice

Appendices

Appendix A: List of Studied Documents

European Union						
No	**Title of the document**	**Year of Publication**	**Author**	**Level of Government**	**Planning Period**	**Relevance to the study**
1	EU Commission- European Overview - Flood Risk Management Plans	2019	European Commission	Supranational	N/A	This EU overview analyzes FRM in all MS. A three-step cyclical approach is demanded: preliminary flood risk assessment, flood hazard and risk maps and FRMPs. MS report all required elements to the EU which assesses them looking at: governance and public participation; the integration of risk assessment and risk maps; measures and action plans; legal coordination; funds, and consideration of climate adaptation strategies.
2	EU Commission Flood risk management Report	2004	Commission of the European Communities	Supranational	N/A	This report is a communication from the Commission to other EU institutions and Member States (MS) on flood risk management, prevention, protection, and mitigation. After stating the diagnosis of the flooding issue across MS, the Commission enumerates FRMSs to be implemented. The document sheds light on what was already implemented, future initiatives and perspectives namely the creation of the European Research Policy, Regional Policy and floods, the European Union Solidarity Fund and Environmental Policy and floods.
3	First River Basin Management Plans- Member State: Denmark	2018	European Commission	Supranational	N/A	This report assesses Denmark's FRMSs and FRMPSs. Flood governance with administrative arrangement, public consultation and information transfers are studied. Good practices, weaknesses, and areas for further development are listed.
4	Second River Basin Management Plans- Member State: France	2019	European Commission	Supranational	N/A	This report evaluates France's FRMSs and FRMPs focusing on governance and public participation, monitoring, assessment of water bodies, FRMPSs and coordination with the WFD. Good practices, weaknesses, and areas for further development are listed.
5	Adaptation preparedness scoreboard Country fiche for France	2018	European Commission	Supranational for France	N/A	This document is accompanied by the evaluation of the EU's climate adaptation strategy. France's overall progress regarding its national adaptation legal scheme is assessed and weaknesses (i.e. coordination between national and local policies) are mentioned. The assessment of risk and vulnerabilities to climate change is pertinent to this study as knowledge gaps and transfers, stakeholders' involvement and coordination are indicated.
6	Adaptation preparedness scoreboard Country fiche for Denmark	2018	European Commission	Supranational for Denmark	N/A	In this report, the EU Commission assesses Denmark's adaptation policy as of June 2018. Adaptation strategies and action plans were examined. Some elements are particularly useful to this thesis such as stakeholders' involvement, coordination structure, monitoring and evaluation of adaptation policies. Flood risk is mentioned as being part of climate adaptation plans written at the local level. With the scoreboard, the EU states the progress of climate adaptation actions.
7	Common Implementation Strategy for The Water Framework Directive (And the Floods Directive	2018	European Commission	Supranational	2019-2021 (work programme)	The Common Implementation Strategy (CIS) is geared towards the successful implementation of the water-related legislation at the supranational level. It was launched in 2001 with the Water Framework Directive and includes now the Floods Directive. The document followed meetings pertaining the assessment of the Commission's second River Basin Managements Plans. Tasks of the CIS are listed and mainly concern exchange of information and lessons learned from experiences, coordination of the legislature. These elements are discussed in this thesis.

8	Forging a Climate-Resilient Europe – the new EU Strategy on Adaptation to Climate Change	2021	European Commission	Supranational	Horizon 2050	This document highlights the need to act now to fight climate change and its underlying negative externalities. The EU Commission recalls the need to better understand the interdependencies between climate change, disasters such as flooding, and ecosystems. Here, the Commission states its commitment to introduce new measures including: transnational knowledge exchange with the climate-ADAPT platform for adaptation, public awareness. These measures intend to improve climate adaptation at different scales of government.
	Rules of Procedure for The Strategic Co-Ordination Group	2018	European Commission	Supranational		The rules of procedure for the strategic Co-ordination group reflects on the Water Framework and Floods Directive CIS. The Strategic Co-ordination group's goal is to evaluate the conclusions of working groups. The stated areas of interest are: objectives (coordination of projects and linkages between working groups, information exchange), participation, organisational issues and decision-making. This document deals with the supranational water/flood governance which is of interest to this thesis.
Nice- France						
No	**Title of the document**	**Year of Publication**	**Author**	**Level of Government**	**Planning Period**	**Relevance to the study**
1	National Climate Adaptation Plan (PNACC 2)	2018	Ministry of Ecological and Solidarity Transition	National	2018-2022	In accordance with the Paris Agreement, the Second National Climate Adaptation Plan seeks to implement adaptation strategies along 6 axes: governance and steering, knowledge and information (awareness raising), prevention and resilience, adaptation and preservation of the environment, vulnerability of the economic sector, and strengthening international action. These themes and underlying measures are closely linked to the goal to reach flood resilience.
2	Bill on combating climate change and strengthening resilience to its effects	2021	Ministry of Ecological and Solidarity Transition, 150 French citizens, Prime Minister	National	Horizon 2050	France's first Citizen's Climate Convention that resulted in a bill. 69 articles were discussed in groups of citizens who had to discuss urban issues such as consumption, production and employment, transport, housing, food, and a strengthen legal framework for the environment. While flooding is not discussed in this legal document, it seemed relevant to assess current climate adaptation strategies that are aimed at strengthening the State's resilience to climate change.
3	Action Programme for Flood Prevention (PAPI)	2011	Ministry of Ecology, Sustainable Development, Transport and Housing (now Ministry of Ecological and Solidarity)	Water catchment/ Local	2011-2017	This document presents the mechanism used to ensure flood prevention at the water catchment level. The underlying objective is to have a global/holistic approach to FRM. Measures on how to enhance knowledge and risk awareness, monitoring of floods, crisis management, and consideration of flood risk in urban planning plans. it also describes how plans that are addressing fluvial, pluvial floods and storm surges are coordinated.
4	Flood Risk Management Plan (PGRI)	2017	Regional Directorate for the Environment, Development and Housing Auvergne-Rhône-Alpes	Regional	2015-2021	The chief concern of this document is FRM, as it lists the territories at risk of flooding (storm surges and fluvial floods) in the region of Nice, informs about the different flood scenarios according to climate change and includes flood risk assessment maps. It also assesses the progress of the main leverages of the flood risk management policies and states local objectives. The PGRI deals with the regional and local flood governance of NCA.
5	Consultation and Follow-up on the processing of stakeholder opinions (from PGRI)	2015 Consultation 12/2014 – 06/2015	Regional Directorate for the Environment, Development and Housing Auvergne-Rhône-Alpes	Regional	2015-2021	The document is a summary of comments and observations of stakeholders involved in the regional Flood Management Plan upon publication. Stakeholders were able to express their inquiry and have the steering committee give an answer to it.

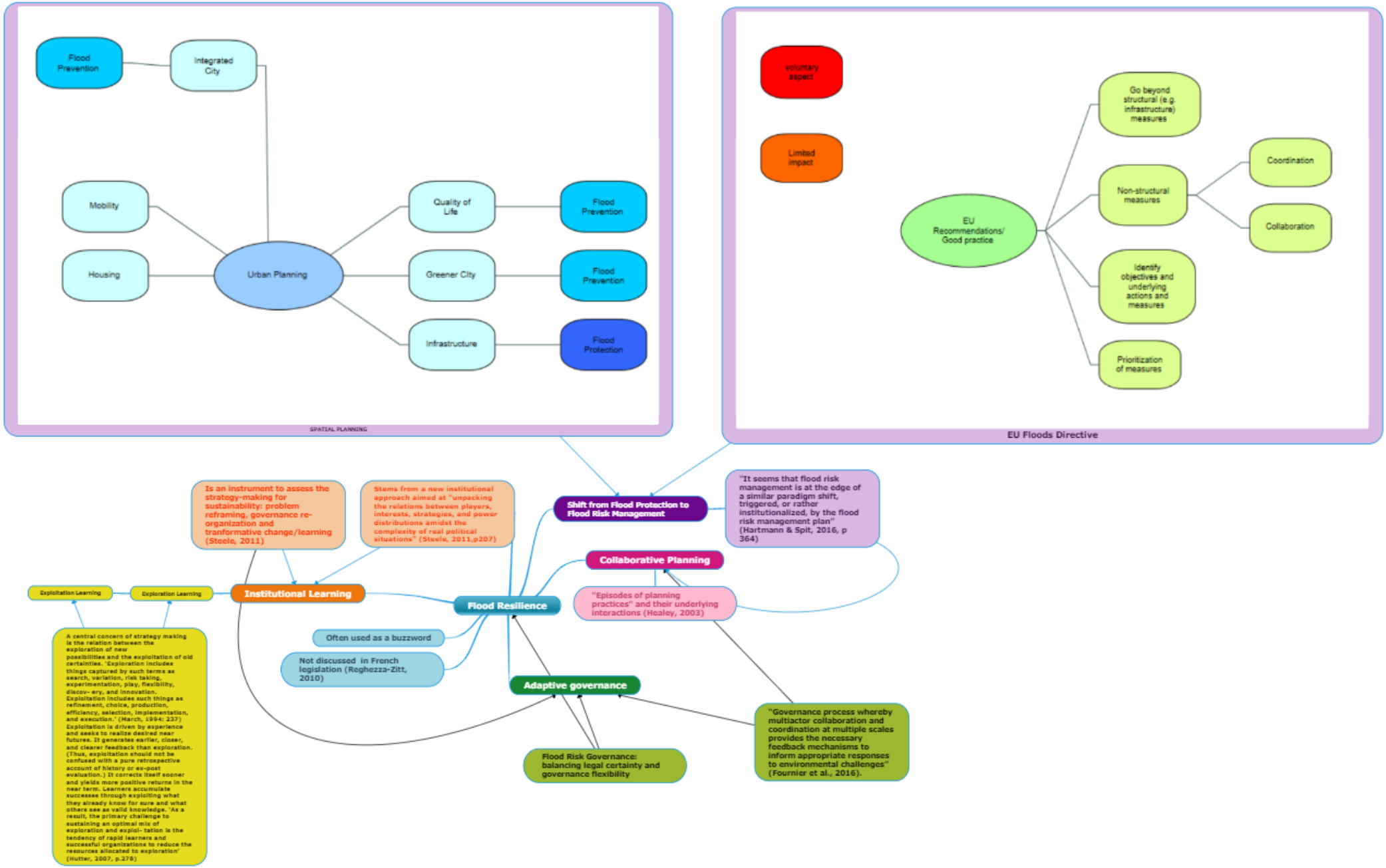
6	Local Strategy of Flood Risk Management	2016	Prefecture of The Alpes-Maritimes	Local	2016-2021	The document deals with the local flood governance, enumerates the potentials impacts of flooding on the population, goods and services, and the environment. It accounts for implementation tools and crisis management. It also reviews the objectives and measures of the local flood management strategy.
7	Metropolitan Master Plan - Analysis of the initial state of the environment (PLUm)	2019	Urban Planning and Development Department	Metropolitan	Horizon 2030	The metropolitan Master Plan is divided into 5 documents dealing with different aspects of urban planning and development. This section describes the articulation of the legal framework. The natural and built environments were surveyed and detailed information on land use, biodiversity, water, agriculture, energy and natural/ technological risks is provided. Particular attention has been paid to the chapter dealing with risks
8	Metropolitan Master Plan- Conclusions of the diagnosis and land use. (PLUm)	2019	Urban Planning and Development Department	Metropolitan	Horizon 2030	The metropolitan Master Plan is the result of territorial diagnostic and public consultation that were sparked in December 2014. This section reviews the findings of the abovementioned territorial diagnostic with goals and needs of the metropolitan region in terms of transportation, land use and densification. The purpose here was to determine whether the PLUm mentions flood risk and the measures taken to address it
9	Metropolitan Master Plan - Environmental assessment (PLUm)	2019	Urban Planning and Development Department	Metropolitan	Horizon 2030	Each municipality was surveyed to assess its environmental features and the impacts of climate change and urban development. Flood risk is mentioned in light of spatial development orientations and within the legal framework as FRM and urban planning plans shall be coordinated.
10	Metropolitan Master Plan- Justification of the Master Plan choices (PLUm)	2019	Urban Planning and Development Department	Metropolitan	Horizon 2030	This document aims at justifying the choices made to develop NCA sustainable development. Justifications pertain to land use to halt urban sprawl, spatial planning, housing and transportation. Climate adaptation appears as chief concern where flood risk is taken into account in development plans, and projects.
11	Metropolitan Master Plan- Sustainable Development Plan (PLUm)	2017	Urban Planning and Development Department	Metropolitan	Horizon 2019	In this document, attention is paid to sustainable development taking into consideration its underlying 3 pillars: ecological, economic, and social. General orientations are stated to develop a metropolitan area which creates job opportunities, protects the environment, ensures quality of life, and solidarity amongst diverse municipalities. Flood risk is not mentioned is this document, yet it provides a broad overview of the development directions NCA is heading towards.
Copenhagen, Denmark						
No	**Title of the document**	**Year of Publication**	**Author**	**Level of Government**	**Planning Period**	**Relevance to the study**
1	National Risk Profile for Denmark	2018	Danish Emergency Management Agency	National	N/A	The objective of this document is to discuss risks likely to occur in Denmark. Interesting to this work are mentions of storm surges, extreme rainfalls, and coastal flooding. For each risk, characteristics, challenge and consequence patterns, and key actors are specified. This document also focuses on knowledge transfer, gathering of information and the overall risk governance.
2	Regional Growth and Development Strategy	2015	The Capital Region of Denmark Centre for Regional Development	Regional	2015-2018 Horizon 2025	This Strategic plan sets the growth objectives of Greater Copenhagen. Green growth is one main objective to build a fossil-free and climate-proofed city. Climate adaptation and prevention are both cited along the need to use them to generate positive effects on climate change. Investments in flood risk are mentioned as part of climate adaptation strategies.
3	Climate Strategy for the Capital Region	2012	Regional Municipality Counsel of the Capital Region	Regional	Horizon 2025	This document describes the regional climate vision to become carbon-neutral by 2025. Interesting to this research: follow-ups of the implementation of this strategy take the form of climate conferences and seminars, where knowledge sharing and exchange occur among politicians, experts, and professionals.

						It is divided into 5 strands: a climate-ready region, climate-friendly transport, conversion to a fossil-free energy system, energy-efficient buildings, and climate-friendly consumption and procurement. Flood risk is discussed in the strand “a climate-ready region” with flood prevention measures.
4	Copenhagen Climate Adaptation Plan	2011	City of Copenhagen	Metropolitan	Horizon 2025	This plan deals with the challenges resulting from climate change faced by Copenhagen. Climate adaptation measures are cited such as green growth, emergency preparedness, legislation and planning. Flooding is mentioned as part of the primary challenges of climate change.
5	Cocreate- Copenhagen	2015	City of Copenhagen- Technical and Environmental Administration Finance Administration	Local	Horizon 2025	In this urban development plan, the city of Copenhagen states its goal to have a liveable and responsible city. Climate adaptation and its underlying strategies are mentioned with emphasis on housing, transportation, and public participation. The city acknowledges the importance of including its residents in spatial planning plans. Flood risk is cited in targets for 2025 and is expected to be reduced by 30% by 2025. By doing so, Copenhagen will become climate-proofed.
6	Copenhagen's Municipal Plan 2015	2015	City of Copenhagen	Local	2015-2019	The chief aim of this plan is to build a coherent city that offers green residential opportunities, quality of life and employment. Climate adaptation and sustainable development are both mentioned and are relevant to this study.
7	Copenhagen's Municipal Plan 2019	2019	City of Copenhagen	Local	2019-2031 (horizon: 12 years)	This is the most recent municipal plan available online. The chief concern is now to be a “world city with responsible” (p.1). It is divided into 3 parts: a political structure, guidelines and a framework for urban development. Flood is mentioned once in the Energy and Environment section whereby climate adaptation solutions to make the city flood resilient.
8	Urban Nature in Copenhagen Strategy	2015	City of Copenhagen	Local	2015-2025	This strategic plan provides an overview of the city’s goals revolving around nature and the environment. More urban nature for Copenhageners and high-quality urban nature are seen as main leverages to enhance Copenhagen’s resilience to climate change.
9	Cloudburst Management Plan- Copenhagen	2012	City of Copenhagen- Technical and Environmental Administration Finance Administration	Local	2012-2033 (horizon: 20 years)	The Cloudburst Plan aims at upgrading Copenhagen’s resilience to extreme rainfalls. In light of the recommendations of the Climate Adaptation Plan, it outlines measures concerning draining stormwater out to the sea, stormwater storage and blue-green infrastructures. Flood governance is discussed with stakeholders’ involvement, legislation, order of priority for measures, and financing.
10	Storm Surge Plan for Copenhagen	2017	City of Copenhagen- Technical and Environmental Administration Finance Administration	Local	2100	This plan was ordered by the City Council and contains the chosen strategic approach to protect Copenhagen from storm surges (i.e. outer protection). It also deals with sea level rising and underlying funding methods. Opportunities for urban development in light of storm surges protection are enumerated especially recreational amenities along Copenhagen Harbour. FRM and urban planning are discussed concomitantly and perceived as interdependent.

Appendix B: Codebook

Name	Description
Climate Adaptation	Process of adapting to the climate (and its impacts) through incremental or transformative measures.
EU Recommendations	List of recommendations for climate adaptation and flood resilience, emanating from the supranational level of government (EU)
Flood Risk Management Strategies	Include a myriad of strategies at different stages of a flood: before (prevention, defence, and mitigation), during (preparedness and response), and after (recovery) (Driessen et al., 2018).
Flood	Natural disaster
Collaboration OR Coordination OR Communication	Collaborative Practices in flood governance
Stakeholder	List of actors that are involved in flood governance
International Context	International narratives on climate adaptation and flood resilience
Knowledge	Strategies to enhanced knowledge about climate adaptation and flooding
Learning	The role of learning to operationalize resilience
Resilience	Ability to "resist, absorb or recover from a shock (such as an extreme flood)" and adapt to change (Bertilsson et al., 2019, p. 971)
Risk	Likelihood of a natural risk/ exposure to danger
Sustainable Development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland, 1987)
Urban-Spatial Planning	Process of developing urban areas
Vulnerability	likelihood of a risk to occur

Appendix C: Mind Map of Literature Review



Appendix D Questionnaire for Interviews in Nice

Objectif spécifique	N°	Questions
Question préalable		Pourriez-vous vous présenter en quelques phrases et présenter votre rôle dans la gestion des risques d'inondation à Nice ?
Comprendre comment les différents acteurs impliqués dans la gestion des inondations communiquent, collaborent et échangent sur leurs connaissances. (Thèmes généraux : Construction de la connaissance Communication et collaboration)	1.1	Qui participe à la gestion du risque d'inondation ? comment les différents acteurs communiquent-ils (de façon formelle ou informelle) ?
	1.2	Comment se fait la communication entre les différentes échelles de gouvernement ? du niveau national au régional, et au local ?
	1.3	D'après vous, quel est le degré de collaboration entre les différents acteurs impliqués dans la gestion des risques d'inondation ?
	1.4	Quelle est la place du secteur privé dans la gestion de la crise ?
	1.5	La collectivité locale a-t-elle appris des inondations de 2015 pour avoir une meilleure gestion en 2019 ?
	1.6	D'après vous, les inondations de 2015 ont-elles eu un impact dans la gestion du risque d'inondation en 2019 ? le cas échéant des modifications ont-elles été observées avant l'inondation (prévention, modification du zonage pour empêcher la construction en zones inondables), pendant, ou après l'inondation ?
Comprendre comment est perçue la gouvernance des inondations à Nice (Thèmes généraux : Prévention des risques, Directive inondation européenne Impacts des textes de lois)	2.1	Pensez-vous qu'à Nice, la gestion des inondations est davantage «réactive» ou «proactive» ? selon vous, à quoi est-ce lié ?
	2.2	Quel a été, d'après vous l'impact de la création de la directive inondation européenne sur la gestion des inondations en France et dans la région PACA?
	2.3	Quel est le poids de l'association Française pour la Prévention des Catastrophes Naturelles (AFPCN) dans la prévention des inondations ?
	2.4	Quel est l'impact des plans de prévention des risques inondation, Plans de gestion des risques d'inondation, programme d'actions de prévention des inondations dans l'approche de Nice ?
Le cas de l'agglomération de Nice, la perception du risque d'inondation et de l'urbanisme (développement urbain)	3.1	Quel est le degré de vulnérabilité de l'agglomération de Nice ?
	3.2	Quelles sont les zones de l'agglomération de Nice les plus à risque ?
	3.3	Que pensez-vous du développement de l'Eco vallée ?
	3.4	Existe-t-il un désir de « vivre avec les inondations » comme on peut le voir dans d'autres pays qui ont connu d'importantes crues tels que les Pays-Bas qui ont lancé un Plan pour laisser place à la rivière ?
Discussion sur la résilience urbaine face aux risques d'inondation	4.1	Comment définissez-vous la résilience urbaine face au risque d'inondation ?
	4.2	Considérez-vous la résilience urbaine comme nécessaire pour faire face aux inondations et leurs externalités négatives ? y-a-t-il, à votre avis, d'autres concepts ou alternatives qui seraient plus efficaces ?

Appendix E: Questionnaire for Interviews in Copenhagen

Specific Objective	N°	Questions
Preliminary question		Could you introduce yourself in a few sentences and your role in flood risk management in Copenhagen?
Understand how the different actors involved in flood management communicate, collaborate and exchange knowledge. (General themes: Knowledge building Communication and collaboration)	1.1	Who is involved in flood risk management? How do the different actors communicate (is it in a formal or informal manner)?
	1.2	How is communication between the different levels of government? from the national to the regional and local levels?
	1.3	How much collaboration do you think there is between the different actors involved in flood risk management?
	1.4	How involved is the private sector in flood risk management?
	1.	In your opinion, did the floods of 2011 have an impact on flood risk management? If so, were any changes observed before the flood (prevention, zoning changes to prevent construction in flood-prone areas), during, or after the flood?
Understanding how the governance of floods in Copenhagen is perceived (General themes: Risk prevention, European Flood Directive Impacts of legal framework	2.1	Do you think that flood management in Copenhagen is more "reactive" or "proactive"?
	2.2	What do you think was the impact of the creation of the European Flood Directive on flood management in Denmark and in Copenhagen?
Copenhagen case study, the perception of flood risk and urban planning (urban development)	3.1	What is the degree of vulnerability of Copenhagen?
	3.2	Which areas in Copenhagen are most at risk?
	3.4	Is there a desire to "live with floods" as seen in other countries that have experienced major floods, such as the Netherlands, which has launched the “Room for the River” Plan?
Discussion on Urban Resilience to Flood Risk	4.1	How do you define urban resilience to flood risk?
	4.2	Do you see urban resilience as necessary to cope with floods and their negative externalities?