URBAN CLIMATE GOVERNANCE IN FRANCE

Limitations and Solutions to Water Governance Capacity in French Mid-Sized Cities

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Abstract

In this report, the authors provide a picture of the climate challenges in France, by focusing primarily on water governance in mid-sized cities. Three case studies are analysed: Saint-Nazaire, Bourg-en-Bresse and Arles. Based on these cities, the report identifies the main water-related threats faced by French territories. The authors lay out the policies of climate adaptation from the international level to the municipal one and how they affect the precious resource. The report then presents a more investigative section in an attempt to understand why France isn't meeting the European targets set to achieve the good status of waters. Broken down into problems identified through interviews and research as well as potential solutions, the section uses the conceptual tool of governance capacity. The latter is divided into five subcategories: legal, resource, managerial, learning and political capacities. Having identified the shortcomings in the water governance of three case studies, the authors offer solutions that can be used by other French mid-sized cities dealing with water-related issues exacerbated by climate change.

Executive Summary

As most of the world's population lives in urban areas, the impacts of climate change will be overwhelmingly felt in cities. For this reason, it is imperative that cities develop robust climate adaptation and mitigation strategies to curb the physical and socioeconomic impacts of climate change. Large cities tend to have greater capacities to govern the ecological transition than mid-sized cities, including access to more economic, human, and technological resources. The focus of this report is to demonstrate the climate-related issues and the governance challenges faced by mid-sized cities in France and propose recommendations for ways to increase their governance capacity. As most physical impacts of climate change in France relate to water, such as drought and flooding, this report analyses climate change governance through the lens of water resource management. Case studies of three mid-sized French cities are presented, each city representing a unique geography with specific climate challenges. The selected cities include the coastal city of Saint-Nazaire, the riverine city of Arles, and the piedmont city of Bourg-en-Bresse. Environmental actors from the three cities, as well as actors from higher levels of government, were interviewed to gain insights into the governance challenges faced by mid-sized cities. The insights from these actors, backed by academic literature, were condensed into concrete challenges and limitations to climate change governance.

This research project is based on the analysis of Comité 21's order, which described three objectives for this capstone project:

- To identify the main current or future changes that will challenge France, thinking about the country of tomorrow;
- To demonstrate how these transformations are related to each other and the current policies in place;
- To identify the shortcomings of the current territorial organisation, and illustrate with proposals for legal and institutional changes at different scales.

Climate change in three cities

In coastal regions, as demonstrated in the case study of Saint-Nazaire, impacts of climate change include flooding and sea level rise

Riverine regions, such as Arles, are subject to flooding, drought, and agricultural loss as a consequence of changes in precipitation patterns

Piedmont regions, where Bourg-en-Bresse is located, are particularly vulnerable to heat waves and drought.

Current policy framework

At the international scale, French policy is shaped by entities such as the United Nations and the European Union. For water, there are European guidelines such as the Water Framework Directive of 2000.

These legal frameworks unite member states through common objectives while allowing the states to create national plans to tailor the directives to their own national contexts. The national government sets guidelines that shape lower levels through schémas directeurs that promote policy coherence.

Water governance in France is multilateral, with both state and local actors responsible for the sustainability of the country's water resources.

Six water agencies

These agencies are the executive bodies governing the six water basins in metropolitan France. Their primary task is to provide funding for different projects in their respective basins. Recent legislation for climate change adaptation has delegated more power to local-level intermunicipalities, or Établissements Publics de Coopération Intercommunale (EPCIs). This includes the competence of flood prevention, or la gestion des milieux aquatiques et la prévention des inondations (GEMAPI). Local level governments are thus faced with increased responsibilities regarding climate change governance. As the impacts of climate change continue to threaten water resources throughout the country, robust climate change policies are more crucial.

Governance challenges and solutions

Challenges and limitations of climate change governance in mid-sized cities, particularly regarding the governance of water resources, are analysed through the framework of governance capacity.

	PROBLEMS	SOLUTIONS
LEGAL CAPACITY	• Decentralization • Trasboundary climate risks	• Contextualising and localizing national policies • Urban planning
RESOURCE CAPACITY	• Lack of economic, human and knowledge resources	• Increased funding • Regulating public-private partnerships • Expertise
MANAGERIAL CAPACITY	• Coordination challenges	• Local Climate Resilience Officers • Adaptation measures with co-benefits • Monitoring/Evaluation systems • Digital governance tools
LEARNING CAPACITY	• Uncertainty • Knowledge and information sharing challenges	• Policy experimentation • Digital engagement tools • Knowledge sharing with different cities
POLITICAL CAPACITY	• Absence of political vision • Lack of vertical support	• Key role of citizens and mayors • Multi-level governance visions • Accountability: meeting targets

Urban Metabolism

Although urban metabolism isn't yet used in many areas of policymaking, it could be explored as an answer to growing climate risks. Cities are not isolated entities, so understanding how they interact with their surrounding regions is a critical component in reducing urban ecological footprints. Urban metabolism is an interdisciplinary approach to studying the sustainability of cities, which focuses on resource flows in and out of cities. Navigating urban climate policies through the lens of urban metabolism enables city officials to view sustainability issues as part of an interconnected system. Identifying material flows with high consumption patterns, for example, can illustrate to officials where they should focus their policies.

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Introduction

This report is written for Comité 21, a Parisian think tank expert in sustainable development counselling private and public actors. It aims to analyse how urban policy can promote climate change resilience in France. In particular, this report focuses on how French cities govern water resources in the context of climate change, defined as an existential and universal crisis with no precedents (IPCC 2022). Water resources are currently, and will continue to be, threatened by global warming more than other kinds of resources.

The most recent IPCC Report on Impacts, Adaptation, and Vulnerability (2022) highlights one of the main challenges faced by European cities: heat waves, which are occurring in France at a faster rate than the global average. Other climate risks include flooding and water scarcity. These are predicted to have socioeconomic impacts, including losses in agricultural production, increases in respiratory and heat-related illnesses, and shifts in energy needs. As the main climate impacts in France are linked to water, this report will focus on the ways in which urban water governance can be resilient in a warming climate. Moreover, as water is governed across different scales in France, this report will also introduce the different roles that the state, regions, departments, agglomerations and municipalities play in the management of water and the related climate change risks.

This report offers a study on mid-sized cities. The French National Institute of Statistics and Economic Studies defines a mid-sized city as having between 20,000 and 200,000 inhabitants (Cosatto & Voisin-Bormuth 2020). In an increasingly urbanized world, cities are the sites of problems but also the critical solvers of these problems. Although bigger cities are more often studied by academics because of their high impact on the climate and their high levels of resources, this report attempts to shed light on the less common topic of mid-sized cities.

The following study is divided into several steps. The first objective is to identify the current and future climate challenges of France. The second objective is to assess the current legal frameworks governing climate change across different administrative scales in France. Mapping the current climate change and water policies in France will provide a foundation for the final objective, which is identifying the shortcomings of the current territorial organisation.

Supported by case studies of three mid-sized French cities (Saint-Nazaire, Arles and Bourg-en-Bresse), the report will conclude with proposals for legal and institutional changes to better promote climate change resilience at the scale of mid-sized cities in France.

The methodological lens of urban metabolism is used as an overarching framework to demonstrate the relationships and flows of materials between cities and their surrounding regions. This metabolic approach illustrates how climate change will impact the water resources of these three cities; the key climate challenges faced by cities; how urban policies can help address these issues; and how French regions can adapt to climate change.

Chapter 1 explores the main climate challenges impacting France and how they are addressed in public policies. This will include the specific physical challenges faced by the three different cities and their regions: Saint-Nazaire and its maritime region; Bourg-en-Bresse and its piedmont agricultural region; and Arles and its riverine region. Then, the chapter will illustrate the different policies targeting climate change and water resources. Finally, Chapter 1 will describe the concept of urban metabolism as a framework for showing how cities and their regions can better face climate challenges.

Chapter 2 focuses on the main governance challenges regarding water and climate change. These challenges were identified through a combination of interviews and literature reviews. The interviews were conducted with elected officials and other relevant actors in the climate policy realm. The framework of governance capacity (Mees and Driessen 2011) will be used in this chapter to discuss the main challenges identified in the water governance sector and more generally climate change governance. Governance capacity can be expanded into five different subsections: legal capacity, managerial capacity, political capacity, resource capacity, and learning capacity.

Chapter 3 is dedicated to strategies for enhancing the governance capacity in French cities in the context of climate change and water issues. This chapter will provide suggestions for enhancing each of the five subsections of governance capacity in the current institutional context. In particular, the chapter will reflect on the effectiveness of current institutional arrangements and suggestions for systemic changes. The final aim of this report is to provide, if not exhaustive answers to these questions, practical guidelines for officials to navigate the field of water governance and climate change with more clarity.

Methodology

Comité 21 has joined forces with students from the "Governing Ecological Transitions in European Cities" Master's at the Urban School of Sciences Po Paris for a collective project on the future of French regions in the context of climate change. This report was written by five students: Madison Cilk, Anna Lefrançois, Philippine Marrière, Margherita Pescarin, and Julie Schwartz. The five students are from different horizons, both in terms of nationalities and field of studies.

This report seeks to understand how urban policy can promote climate change resilience in France. Specifically, the report focuses on the governance of water in French mid-sized cities, as most physical impacts of climate change in the country are linked in some capacity to water. Through the use of interviews and literature reviews, this study identifies the main challenges that Saint-Nazaire, Arles, and Bourg-en-Bresse will face in the coming years to highlight the perspective of mid-sized cities on the issue of water management. This report aims to provide local decision-makers with insights on the challenges of urban climate governance and possible solutions to increase governance capacity.

Case Studies

The three cities studied in this report have overlapping water problems, and are linked to different situations aggravated by climate change. However, they do have dominant problems that have been identified, and which have therefore been used to produce a tool to focus on the main priorities of the cities, according to their geographical context and main issues. In accordance with Comité 21, the cities selected were Saint-Nazaire, Arles and Bourg-en-Bresse. The three mid-sized cities are the largest in their respective agglomerations, resulting in the participation of both local and agglomeration-level governance.

The size of the cities illustrates a specific capacity of municipal action and mid-sized cities are also a testing terrain of climate-related issues for public authorities, as demonstrated in this report with the example of water resources.

Academic research on climate change often focuses on larger cities, leaving a knowledge gap in mid-sized city governance which has "received too little attention to this day" (Growe and Wagner 2021). Despite their smaller size, mid-sized are also actors of the ecological transition and have a crucial role to play.

Saint-Nazaire, Arles and Bourg-en-Bresse are also located in different regions of France and will face water challenges of climate change in different ways as their waterscapes and territorial configurations are varied, resulting in particular water fragilities.

A. Saint-Nazaire: Challenges in Coastal Regions

Saint-Nazaire is classified as a maritime city, with a surface of 46.79 km2 spread over the estuarine area of the Loire, France's largest river. The coastal city to the Atlantic Ocean counted 71 394 inhabitants in 2019, but the homonym agglomeration counts 188 334 inhabitants (Ville de Saint-Nazaire 2022). These figures allow Saint-Nazaire to be considered a 'ville moyenne' - a mid-sized city - in the geographic landscape of France.

In addition, Saint-Nazaire is considered the shipbuilding capital of France. The Chantiers de l'Atlantique in Saint-Nazaire is one of the largest sites in the world, building the largest ships to date, and the local economy and development heavily relies on its water resources (Nantes Metropole 2012).

Figure 1: Image of flooding in Saint-Nazaire (Bouliou 2020)

The shape of the Loire dictated the progressive urbanisation of the area, which started in nearby Nantes. Alongside Nantes - the capital of the Loire Atlantique - Saint-Nazaire is part of a broader urban development project that aims at creating an eco-metropolis. At the heart of this eco-metropolis, there are 1,500 kilometers of waterways: a natural habitat for wildlife and biodiversity, which makes water the essential composition element of the binomial Nantes - Saint-Nazaire (Nantes Metropole 2012). Saint-Nazaire presents typical coastal challenges, exacerbated by the phenomena of climate change. In particular, the most salient challenges include excess of water, as came up from the interviews and is supported by scientific predictions (Marin 2020). This excess of water manifests in flooding (as seen in Figure 1) and sea-level rise, extreme weather events such as storm surges, agricultural loss, and water quality degradation with issues of pollution rising.

Figure 2: Map of flood risks zones in France (Kolen et al. 2010)

B. Arles: Challenges in Riverine Regions

Arles is located in the Provence-Alpes-Côte d'Azur region and is composed of only one canton which presents the most extended surface of metropolitan France with a surface of 759 km2 and a population of 53 629 inhabitants. Insightfully, this explains its different physical attributes (e.g., riverine and agricultural). Arles presents a high percentage of agricultural land, making its territory very diversified and subject to different climate change hazards. Its corresponding agglomeration, the Communauté d'agglomération Arles-Crau-Camargue-Montagnette, counts 83 546 inhabitants, allowing Arles also to be categorised as a 'ville moyenne' (Annuaire Mairie Arles-Crau-Camargue-Montagnette 2022).

Figure 3: Map of Pays d'Arles (Pays d'Arles, 2022)

Arles is a fluvial city with a rich history. Colonised by the Romans, it was built on the banks of the Rhône river. Arles is located in the Southern region of Provence, at the mouth of the Rhône delta, which flows into the Mediterranean. In Arles' municipality, three natural areas cross each other: the 'Alpilles' (hills); La Crau (plain); and La Camargue, a natural protected area of paralic wetlands that displays a high variety of biodiversity, fauna, and flora. The most outstanding example is the Greater Flamingo population, which is already affected by climate change (Bechet and Johnson 2008).

As **Figure 2** in Section A illustrates, the whole delta region of Arles is majorly exposed to flooding risks. Having a Mediterranean climate, Arles is and will continue to be subjected to sea level rise, which is expected to reach at least 1 metre by 2100. Thus, the coastline could be gradually eaten away and cause widespread flooding. The climate challenges of Arles include those faced by Bourg-en-Bresse and Saint-Nazaire: flooding and sea level rise, heatwaves and droughts, water scarcity impacting local agricultural production and human resources. Arles will particularly suffer from severe droughts intensified in their magnitude and frequency by climate change: water resources in Arles require protection to avoid further socioeconomic impacts.

C. Bourg-en-Bresse: Challenges in Piedmont Regions

Situated within the Ain department in the Auvergne-Rhône-Alpes region, the municipality of Bourg-en-Bresse alone counts 41 248 inhabitants. The city is part of an intermunicipality, the 'Communauté d'agglomération du Bassin de Bourg-en-Bresse', which counts 132 380 inhabitants overall.

Bourg-en-Bresse is a mid-sized piedmont city located to the west of the Jura mountains - on the south-eastern edge of the Bresse plains - and on the left bank of the Reyssouze, a tributary of the Saone. This signifies that Bourg-en-Bresse is neither an 'alpine' city nor a 'riverine' city as the size of Reyssouze is not significant enough to define the entire morphology of the city. Rather, the municipality of Bourg-en-Bresse can be considered mostly agricultural as 64% of the agglomeration is agricultural (Grand Bourg Agglomeration 2018).

Bourg-en-Bresse has cold winters and hot summers. Rainfall occurs mostly during the summer, but precipitation levels have diminished considerably since 1979. This is most likely due to the rising numbers of heat waves and drier seasons over the decades (Grassaud and Tardy 2019). The area is not deficient in terms of resources today, several interviewed experts of the region have stated. However, because of shortage of rainfall and increasing temperatures, the two drinking water catchments that 'feed' Bourg-en-Bresse will be threatened in years to come. The challenges Bourg-en-Bresse is facing and will continue to face in the following years due to exacerbating climate change can be grouped into the following categories: heatwaves and droughts, agricultural loss, water quality, and infrastructural deterioration.

Despite not having direct contact to the sea or larger rivers and thus not being initially considered as vulnerable to water risks as other cities, Bourg-en-Bresse will still be threatened by climate change. Including this city in the report contributes to the diversity in a range of challenges faced by French cities. The focus on Bourg-en-Bresse shows how different urban contexts will each be impacted by the effects of climate change and how they can promote sustainability.

The geographical differences of the three cities illustrates the specificities of climate change depending on the local contexts and governance challenges stemming from it. This enables a wider application of the suggested solutions.

Sources of Information

The first part of the report includes a literature review of urban climate change and water governance strategies to identify the main problems that mid-sized cities are facing. Information was gathered from scientific reports, academic articles, and local climate plans. This background knowledge was supported by the contribution of governmental and non-governmental actors from various backgrounds, including elected officials, urban project managers, companies, local actors, and public utility managers. The objective was to gather data on climate change in France. Subsequently, the focus was placed on water management and the future of the resource in the territory because as was mentioned in the introduction, water is linked to most climate challenges. The objective was to answer the main research questions: what are the key climate challenges in France? And how will climate change impact water resources in the French territory?

In order to understand the relationship between written climate policies and the actual implementation of the policies, it is necessary to highlight the roles played by relevant actors and how local priorities may not align with policy objectives. For this reason, the second part of the research involved interviews with governance actors to gain insights into the challenges relating to the local application of national directives. The combination of the preliminary research with this field research is condensed into this report, which is divided into three chapters: Climate Change and Policies in France; Water and Climate Change Governance Challenges; Proposed Solutions to Governance Challenges.

The first interviews aimed to study the future of the water resource through the concept of urban metabolism, in order to understand how the resource is managed at local or regional level, in different governance contexts (municipal or inter-municipal). The final interviews were conducted with local elected officials and people working in the public sector (ministries and public agencies). It was also an opportunity to get feedback on the expectations of these stakeholders in relation to the tools that will be developed to analyse the problems and present solutions in Chapter 3.

Actors interviewed

BLANCHOUIN Florentin - Regional Planning Officer Chambre de Commerce et d'Industrie (CCI) - Nantes-Saint Nazaire

BOUTAULT Pascale - Program manager of Circular economy at the Conseil régional de la Loire

BURTIN Martine - Director Aménagement, projet de territoire et foncier - Grand Bourg Agglomération

CAPOSIENA Jerome - Consultant in Energy - CCI - Ain

DEVILLARD Bertrand - Director "Préservation et Gestion de ressources" - Grand Bourg Agglomération

DUVAL Annabelle - PhD student in Port Metabolism, Université de Nantes

FABRE Bathilde - Sustainable Development Advisor at CCI Nantes-Saint Nazaire

GINDRE Jonathan - Mayor of Corveissiat, Vice president in charge of Water and Energy (agglomération Bourg-en-Bresse)

GRESSOT Cyril - Fisherman in Arles

HAZET Charles - Direction of Water and Biodiversity at the Ministry of the Ecological Transition

JOLIVET Alexandre - Director of the Grand cycle de l'eau in the Agglomeration of Bourg-en-Bresse

LAFLEUR Alexandre - Director of the Syndicat Bassin Versant Reyssouze

LEBLANC Jean-Sébastien - CARENE archivist

LORTIE Elsa - In charge of the Mission Eau - CCI Pays de la Loire

MALHAIRE Stéphane - Director of the Cycle de l'eau CARENE

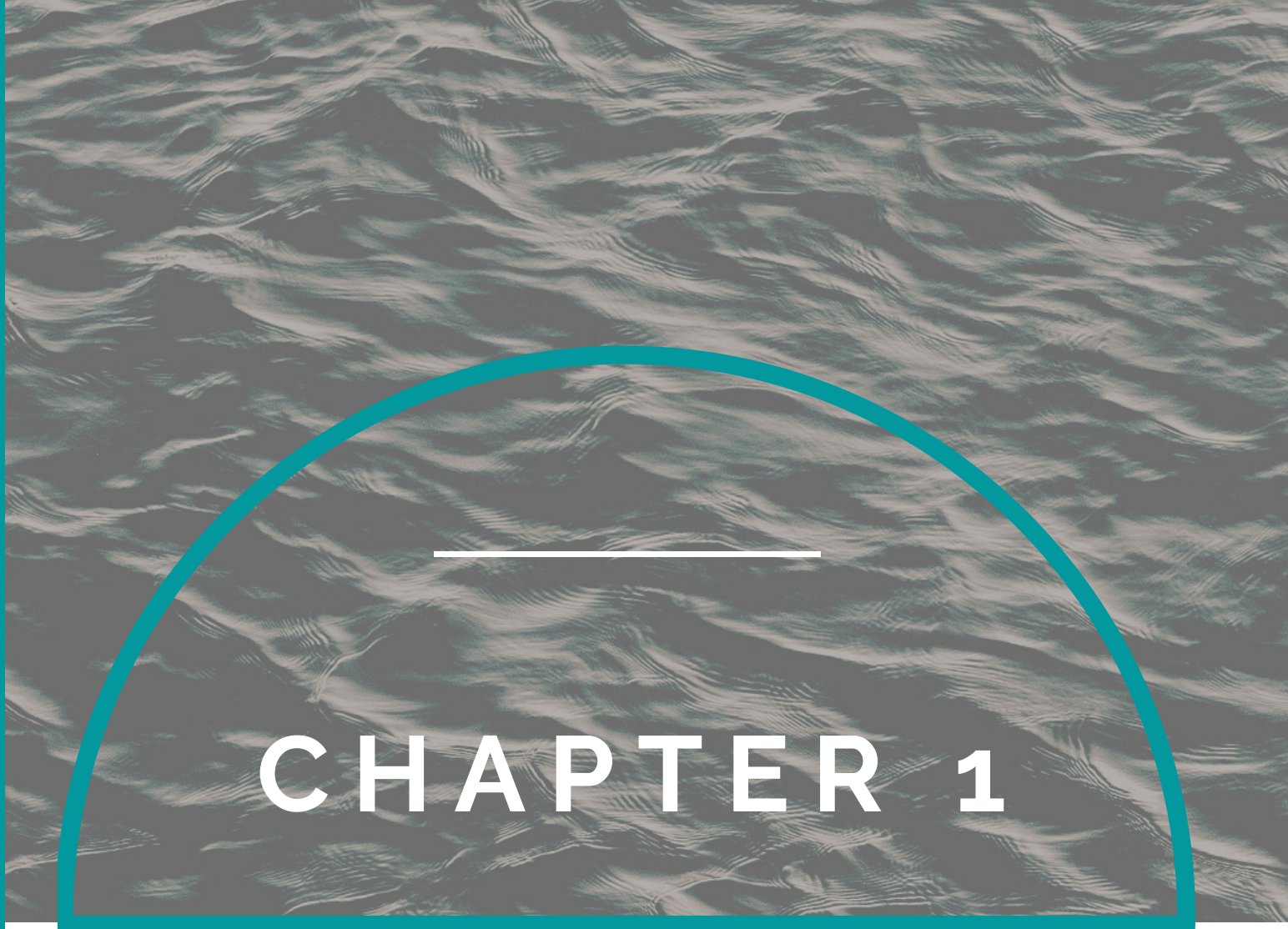
NAULEAU Marie-Laure - ADEME Pays de la Loire - Pôle Territoires Durables

SARTRE Aude & COUFFIGNAL Laurine - Comité 21 members - In charge of territories

SIOU Yvon - Mission manager at the Agence de l'eau Loire - Bretagne

SIVADE Eve & BOUR Lysanne - Regional referent of "Partage de l'Eau et changement climatique" at the Agence de l'Eau (Rhône)

VIONNET Pierre - Director of the ADDRN



CHAPTER 1

CLIMATE CHANGE AND POLICIES IN FRANCE

INTRODUCTION

According to a pivotal article published by *Ecology and Society* (2009), there are nine major planetary boundaries that must not be transgressed to help prevent unacceptable environmental change. In this article, Johan Rockström and his colleagues identified how close human activities have brought us to crossing these biophysical thresholds, which could have disastrous consequences for humanity, potentially triggering "non-linear, abrupt environmental change within continental-scale to planetary-scale systems." Climate change is the most salient of these planetary boundaries, resulting from greenhouse gas emissions. Due to a rapidly growing reliance on fossil fuels and industrialised forms of agriculture since the 19th century, human activities have increased the temperature of the planet by 1 degree Celsius compared to pre-industrial levels. This warming is unprecedented for the short time frame during which it has occured: it is happening 10 to 30 times faster than other moments when the Earth was subjected to temperature change.

After focusing on the key climate change impacts that affect metropolitan France, Chapter 1 unveils the particular challenges faced by French mid-sized cities. This chapter elaborates on water, a crucial yet highly threatened resource that is representative of larger climate and governance challenges. To understand what climate-related challenges mid-sized cities are faced with, this chapter delves into three case studies: Saint-Nazaire, Arles and Bourg-en-Bresse. These cities are confronted with climate hazards that affect water and other resources around the country, and they also encounter issues that are specific to the regions they are in. By describing these specific challenges, Chapter 1 aims to shed light on a scale of analysis that is often less discussed in the climate-related literature. This analysis also seeks to demonstrate how climate change and its physical impacts play a role in the elaboration of public policies in different scales of governance. In this chapter, the concept of urban metabolism is described as a relevant methodology to provide insights into the adaptation to climate change for and by cities. Finally, the specificity of water governance is described in this chapter to provide an overview of how this resource is governed in France.

PART 1

PHYSICAL IMPACTS OF CLIMATE CHANGE IN FRANCE

NATIONAL CLIMATE CHALLENGES

Climate change is already being felt in France through warmer and more destructive seasons. The rate of warming has varied, with a particularly marked increase since the 1980s (Météo France 2022), reaching 0.95 °C of warming in mainland France today, compared to 0.74 °C globally. In the past three years, France has recorded its hottest summers in history, reaching its highest ever temperature in 2019 (45 °C near Nîmes). The OECD (2013) observes that from the 1980s "average temperatures [in France] have risen rapidly, faster than the global average" (151). In addition to this, to this, France is subject to rising sea levels due to the melting of ice in the Arctic. The current annual rise is approximately 3mm per year (World Bank Climate Change Knowledge Portal 2022), with major cities at risk of being submerged such as Bordeaux, Saint-Malo, Calais and Dunkirk. Of the 126 French municipalities that will be forced to adapt to coastal erosion, 41 are located in Brittany, 31 in New Aquitaine, and 16 in Normandy (L'Obs and l'AFP 2022). The risk of exposure to exceptional marine submersions in France could affect at least 500,000 people with an anticipated rise in sea level of one meter by the end of the century, compared with less than 100,000 today (GEO 2022).

The French territory is exposed to events such as avalanches, storms, forest fires, floods, and landslides. Urban areas are particularly vulnerable to these hazards, as the higher the population density, the greater the exposure. In Chapter 6 of the IPCC report on adaptation, 'Cities, Settlements and Key Infrastructure', the authors revealed that the risks faced by people and assets from hazards associated with climate change have increased in all cities since the last report; and that observed losses in urban areas now arise from single, compounding, cascading and systemic events (2022). The climate hazards are becoming more frequent, widespread, and intense. According to the report, the extent of the risks felt in urban areas depends more than ever on urban land use planning, which can reduce exposure to risks especially for marginal populations, thus stressing the important role of local elected officials.

WATER: A RESOURCE AT THE CORE OF CLIMATE CHANGE IMPACTS

In recent years, the issue of water has occupied a central place in the French media, notably due to the direct impact it has on the daily life of farmers. Water has been subject to stress for centuries, but climatic pressures are producing new uncertainties regarding the management of this crucial resource. The IPCC (2022) identifies three main macro-fields of water-related challenges exacerbated by climate change in Europe: the loss of agricultural production due to combined heat and droughts; water scarcity that can affect all types of landscapes; and flooding, especially intensified in riverine and maritime landscapes. Scientists predict that by 2050, these challenges will affect European cities:

- A significant increase of days with low water levels
- A "reduction in the quantity of water resources, coupled with a potential increase in anthropogenic pressure due to demographic growth [that] could have significant impacts on water quality
- An increase of summer droughts in all regions of France

Freshwater represents only 2.5% of the total quantity of water on Earth (Lefèvre 2022). It is one of the nine regulators of the state of the Earth system that are included in the planetary boundary framework aforementioned, and is the sixth boundary that scientists have assessed as being transgressed due to human activities (Wang-Erlandsson 2022). The freshwater cycle is at the heart of life on Earth, because humans use "blue water" coming from lakes and rivers to sustain themselves, and "green water" that is contained in soils and vital to plants and microorganisms to regenerate soils. The capacity of soils to retain green water is necessary for agriculture, and thus essential for humans. In France, the freshwater cycle has been highly compromised by heat waves and droughts, as well as by the global transgression of the phosphorus and the nitrogen planetary boundaries, showing the interconnectedness of climate change and water. While warmer temperatures can sometimes increase agricultural yields in the North of France due to longer growing seasons and less risk of frost, droughts increasingly threaten crops in the South (AgriAdapt 2017).

Droughts and water scarcity are a growing concern for France, causing more wildfires and low access to drinking water in the South (Ruffault 2017). In the past 5 years, some areas of France had to be supplied with extra water by truck due to extremely low water levels.

Several years in a row, the Aude Département only had 2 hours of water a day during droughts. These data show that the growing impacts of climate change on water are unequally affecting the French territory, highlighting the importance of tailoring climate change adaptation to local conditions. Water management issues are currently not caused by a lack of production or technical systems, but mostly by issues of resource availability due to lack of freshwater oandr pollution. If the current rate of water consumption and waste continues, the world will face a global water deficit of 40% (Valo 2019) that will continue to impact the French territory.

WATER CHALLENGES IN THREE FRENCH CITIES

As shown previously, the French territory is faced with many climate-related challenges, a large number of which involve water. This crucial resource is highly connected to the different planetary boundaries and needs to be understood at the level of local policymakers. The following section delves deeper into the climate and water challenges faced by specific territories of France with the case studies chosen for this report.

A. Saint-Nazaire: Challenges in Coastal Regions

Flooding and Sea Level Rise

The eastern part of the municipality of Saint-Nazaire is located on alluvial land between the marshlands of the Brière and the Loire estuary. On the western part, there are the Guérande hills with a granitic base. As a town partially built on marshland, Saint-Nazaire is potentially more exposed, and thus more vulnerable to flooding. As seen above (Figure 2, page 16) displays Saint-Nazaire as one of the various coastal municipalities to be most prone to flooding in case of a sea-level rise of 2 metres on average. This is especially threatening, as the municipality's altitude varies between 2 and 45 metres above sea level, which means that some parts of the municipality would not be able to escape episodes of flooding. The picture is even more worrisome, as the sea level of the Atlantic is expected to rise dramatically by 2050 (IPCC 2022).

In addition, the risks of flooding are amplified by the fact that the coastline has been severely urbanised, causing an acceleration of coastal erosion. This has been a catalyst for more frequent and violent storms, as less quantity of land means less quality of buffer zones for storms to land on.

Agricultural Loss

The 1500 kilometres of waterways characterising the estuarine region of Nantes and Saint-Nazaire are surrounded by urbanised and agricultural areas. Data shows that 45% of the intermunicipality of Saint-Nazaire is agricultural land (Nantes Metropole 2012). Thus, episodes of flooding occurring now, caused by possible overflooding of the Loire and sea-level rise, are potential threats to agricultural productivity in the present and years from now.

Water Quality

Another water-related issue is the quality of the waterways and water pollution. The Pays de la Loire region is one of the most polluted in France, claimed regional experts in the water governance sector. In the city of Saint-Nazaire, this is also due to the presence of a large port industry with very high quantities of materials used and polluting discharges which threaten the ecosystem of Saint-Nazaire and the surrounding estuarine territory.

B. Arles: Challenges in Riverine Regions

Flooding and Sea Level Rise

Unlike Saint-Nazaire, Arles is not directly facing the sea, but is subject to flooding and sea-level rise because of low elevation and its position on the delta of the Rhône. As the city is built on a wetland, the territory has historically struggled with flooding events. However, the city might be better prepared than other areas prone to flooding since elected officials have historically had to adapt to this threat. It is critical that the city continue to strengthen resilience strategies. Another effect of climate change on water in Arles is that it is getting warmer, which can affect the aquatic flora. Additionally, Rhodanian cities that are overdeveloped on riverbanks, such as Arles, are more heavily threatened by exposure to flooding because of the consequent unpredictable behaviour of the Rhône – historically known to be a tumultuous river.

Figure 4: Picture of the historic centre of Arles (Thornton 2020)

Heat Waves and Droughts

Arles has a Mediterranean climate due to its geographical latitude, heatwaves and consequent droughts. In future years, these physical changes will impact the municipality of Arles more intensely for longer periods of time. Contrary to Bourg-en-Bresse, which benefits from being located in a piedmont region and thus influenced by higher altitudes, Arles is more humid due to its closer proximity to the sea and thus has higher perceived temperatures.

Agricultural Loss

The presence of the Rhône allows the region around Arles to be fertile for agriculture, as well as the extended surface of its municipality which manages to include an even larger agricultural area. This agricultural surface, in contrast to Saint-Nazaire and Bourg-en-Bresse, is affected by potential flooding risks and heat waves which lead to droughts. It is important to highlight that the problem of agricultural loss is a particularly worrying one for the municipality of Arles, as it is potentially caused by these two factors. When combined together or in subsequent phases, floods and heat waves can devastatingly aggravate the already fragile climate conditions of Arles.

C. Bourg-en-Bresse

Heat Waves and Drought

Average yearly temperatures are increasing in Bourg-en-Bresse (see **Figure 5**). Median temperatures in the region of the Auvergne will rise by +1.5 degrees Celsius in winter and by +2.9 degrees Celsius in summer. In addition to the shortage of rainfall already accounted for, the rising temperatures will contribute to an increasing number of heat waves. In turn, these will lead to drier seasons characterised by droughts of waterways.

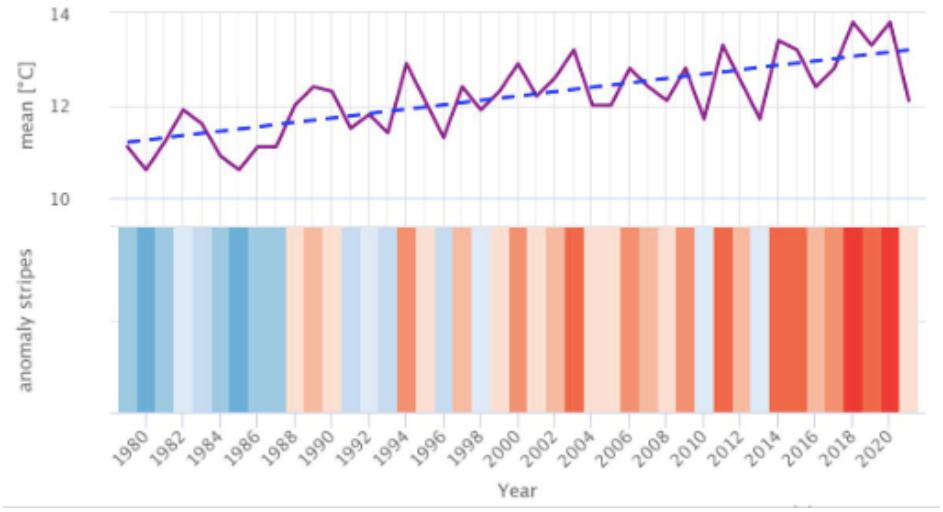


Figure 5: Average yearly trend and anomaly in Bourg-en-Bresse, 1979-2022 (Meteoblue 2022)

Agricultural Loss

Heat waves could lead to the loss of agricultural land, as 64% of the intermunicipality's territory is made of agricultural land (Agglomeration Plan Climat 2018). If heat waves intensify with the rising temperatures, these areas will especially suffer due to water scarcity which could lead to the seasonal failure of crops. In addition, the artificial rivers around the city are problematic because of the lack of watercourse structure. The city is working on programs to rehabilitate and restore the functions of these rivers, but also to create new wetlands in agricultural and forest areas - say experts from the Reyssouze basin - particularly around the Reyssouze estate. The final objective is always to guarantee the preservation of water in these areas in order to ensure optimal quantities for the various sectors.

Water Quality

As a municipality predominantly surrounded by agricultural lands, agricultural pollution is an important threat to Bourg-en-Bresse. For example, the release of pesticides used by agro-industrial factories into streams is a main cause of pollution of waterways in the Bresse region. These pesticides not only kill the aquatic flora and fauna but can also lead to widespread pollution of water basins.

Infrastructure Deterioration

Finally, the municipality of Bourg-en-Bresse also faces infrastructure problems. Deteriorating structures are letting large quantities of water escape because of technical defaults. However, their maintenance costs cannot be met by the city alone, say two elected officials, often due to the little administrative power present in smaller municipalities.

PART 2

INTRODUCTION

As the first part of Chapter 1 revealed, French mid-sized cities are threatened by growing challenges due to climate insecurities. In the water sector specifically, the French territory is increasingly exposed to hazards that affect populations directly through floods, heat waves and water scarcity, and indirectly through agricultural loss. By 2050, the United Nations (2019) predicts that seven out of ten people will live in urban areas. As areas of dense human activity, cities are centres of concentrated energy and material consumption and waste production (García-Guaita et al. 2018; United Nations 2022). Despite covering a fraction of the world's surface, urban areas are major contributors to climate change; cities use nearly 80% of the world's energy and produce nearly 70% of the global greenhouse gas emissions (International Energy Agency 2021). However, although mid-sized cities are exposed to risks, they can also play a central role in addressing those aforementioned challenges (OECD, 2008). Urban climate policies are thus highly relevant for the well-being of both urban and planetary health and they will be explored in this section.

French climate change policy is shaped by international, national, regional, and local policies. At the international scale, French policy is shaped by entities such as the United Nations and European Union. International agreements provide overarching frameworks that can be adapted to the French national context. The national government then sets guidelines that shape lower administrative levels. As the impacts of climate change continue to threaten water resources throughout the country, robust climate change policies are ever more crucial.

THE INTERNATIONAL LEVEL

As a result of the rising climate related problems, the UN created the United Nations Framework Convention on Climate Change (UNFCCC) and adopted the Paris Agreement in 2015, thus binding France and 191 other countries to work towards capping global warming at 1.5 degrees, which is expected between 2030 and 2052 if it continues to increase at the current rate. This binding agreement imposes an obligation for Member States to lower their greenhouse gas emissions, which gives climate change adaptation the same priority as mitigation. This affects all sectors of the economy, including the water sector. For example, the use of bioenergy with carbon capture and storage (BECCS) as an alternative to fossil fuel energy uses considerable quantities of water (Dombrowsky, Bauer and Scheumann 2016). However, a warmer world would similarly increase pressure on water resources, so the water sector is inherently linked to the climate targets set by the UNFCCC.

France has also adopted the 2030 Agenda for Sustainable Development, which is based on the Paris Agreement and outlines ways for signatories to reach the goals set by the UN. The SDGs aim to transform the world by eradicating poverty and inequality, and ensuring an ecological and inclusive transition by 2030 (United Nations 2022). The objectives are based on three challenges for the coming years: to ensure a realistic assessment of the situation to implement rigorous monitoring of the progress made; to create a dynamic for the appropriation of the sustainable development objectives by the regions, civil society, the private sector and citizens; and to foster a context of cooperation to disseminate good practices and to build a framework of cooperation between the actors. Goal 6 of the SDGs is focused on water and highlights the need for equal access to clean water and sanitation for all. Recently, the UN has pointed out the importance of this goal for everyone to have access to good hygiene during the Covid-19 pandemic. The Nationally-Determined Contributions (NDCs) shape national policies to meet the goals of the international agreement. This is reflected by the implementation of national climate plans, which will be outlined in the next section.

Finally, as France is a member of the European Union (EU), it is subject to its regulations. The latest big EU agreement on climate change is the European Green Deal. It seeks to meet three targets for member countries: zero net emissions of greenhouse gases by 2050; economic growth decoupled from resource use; and no person or place left behind (European Commission 2022). The plan focuses on the energy, transport, and taxation policies to reduce greenhouse gas emissions by 55% by 2030, compared to 1990. Similarly to the Paris Agreement goals, these targets are not directly related to the water sector but they are still highly relevant due to the impact of energy use and global temperatures on the resource.

THE NATIONAL LEVEL

In continuity with the international agreements, France sets climate targets at the national level. The concept of ecological transition grew steadily in France in the 2000s and particularly in the past few years with the creation of the Ministry for the Ecological Transition and Solidarity in 2017. Climate change policy is primarily governed by this ministry. The Ministry for the Ecological Transition sets national directives, including the Grenelles I and II from 2009 and 2010. These two directives formalised environmental commitments across all levels of the French government. The key measures were based on the harmonisation of policy and planning documents, in particular, relevant to the agglomeration level. These measures contributed to the goal of drastic GHG emissions reduction.

In 2015, the Ministries for the Ecological Transition and the Energy Transition presented the law on energy transition and green growth. According to Gest'eau (2015), a community of actors from the water related sectors, this law on renewable energy and protection of the environment highly impacts the water sectors. It puts hydroelectricity at the forefront of renewable alternatives to fossil fuels, it highlights the role of fluvial transport, and importantly it dictates how new housing must be built in order to respect new regulations on water consumption and sanitation networks.

In 2019, the Ministry of the Ecological Transition defined six challenges that the territory must address:

- Acting for a just transition
- Transforming society models through carbon sobriety and the economy of natural resources
- Relying on lifelong education and training to enable a change in behaviour and lifestyles
- Acting for the health and well-being of all, through healthy and sustainable food and agriculture
- Making effective citizen participation in the achievement of sustainable development objectives and giving concrete expression to the transformation of practices through territorial innovation
- Working at the European and international level for the sustainable transformation of societies, peace, and solidarity.

French climate change laws also rely on compliance with the Environmental Code. The latter groups together laws relating to the environment in seven areas: provisions common to the territory; the protection of physical environments; natural spaces; fauna and flora; the prevention of pollution, risks, and nuisances; provisions applicable to overseas regions; and environmental protection in Antarctica (Légifrance 2022).

THE LOCAL LEVEL : PLANNING DOCUMENTS

France is a historically very centralized government, but in 1983, the country undertook an administrative decentralisation movement to give more responsibilities to local authorities on issues related to economic and social development, culture, land planning and environmental management (Mediterranean Coastal Foundation 2015). Since then, municipalities and intermunicipalities have had more authority to decide their future through local planning documents. International institutions and city networks advocate for the decentralisation of functions to the local level to close the gap between the city and the society and to tailor services to what is really needed in the cities. As a result of this decentralisation, local authorities have gained responsibility in the water sector and other climate related subjects.

In 2018, the French government started a programme called "Action cœur de ville" to guide cities in their appropriation of the national laws on the ecological transition. The programme stipulates that the ecological transition is cross-sectional and should be taken into account in the main competencies that municipalities can have an impact on: housing, economic development, accessibility and mobility, public space and access to public services. In a report published by an entity of the Ministère de la Cohésion des Territoires et des Relations avec les Collectivités Territoriales (CGET 2019), the authors found that many municipalities were able to incorporate climate related policies into their agenda thanks to calls for projects proposed by the State. They indicate that French agglomerations' climate strategies almost all cover the topics of renewable energy, sobriety, water and sanitation, waste, and biodiversity.

The authors of the report also mention the importance of planning documents for local policymakers to guide the ecological transition at their level. The report shows that French municipalities most often use the Local Agenda 21, a programme elaborated and supported by the State until 2015, to guide their ecological transition. They also majorly use the compulsory PLUs or Plan Local d'Urbanisme.

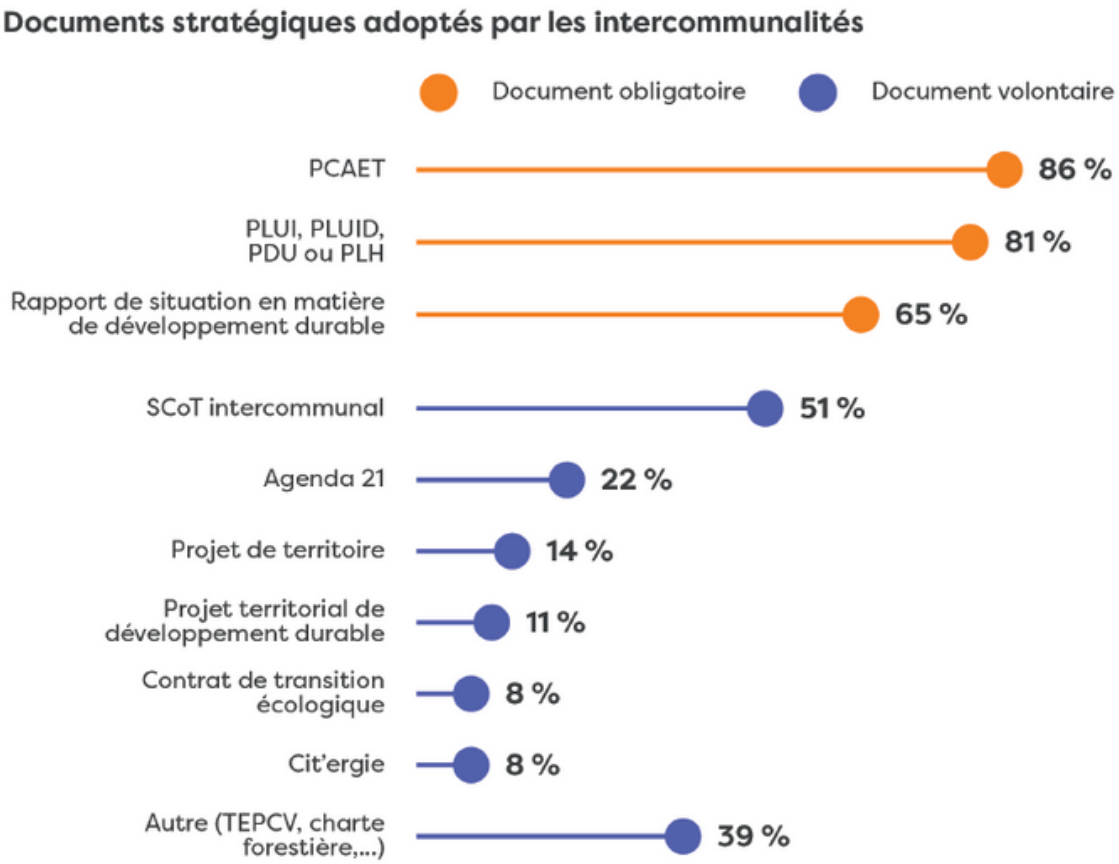


Figure 6: Planning Documents most used by intermunicipalities (CGET 2019)

As **Figure 6** shows, agglomerations use similar instruments as well as the PCAET, or Plan Climat-Air-Énergie Territorial which is a tool allowing EPCIs to tackle the air-energy-climate nexus as a whole, and the SCoT Intercommunal, or the Schéma de Cohérence Territoriale.

URBAN METABOLISM AS A FRAMEWORK FOR POLICY

MEASUREMENT TOOL	DESCRIPTION	DRAWBACKS
Material Flow Analysis	Classifies different material flows and creates a balance sheet accounting the flows. Facilitates resource and environmental management	Does not account for energy flows or the quality of the materials
Energy Flow Analysis	A modification of MFA which accounts for differences in quality of materials and energy	Lacking a unified approach to account for waste
Life Cycle Assessment	Calculates all upstream and downstream environmental impacts of different materials	Complex to measure, difficulty accessing data
Ecological Footprint Analysis	Socioeconomic development demand is computed in relation to the environment's supply capacity. Can highlight unsustainable development practices	Lacking a unified measurement of environmental supply areas
Urban Carbon Metabolism	Compares carbon fluxes of the natural carbon cycle with human-generated carbon fluxes	Not all carbon metabolic fluxes are understood and quantifiable

Figure 7: Main measurement methods for urban metabolism (adopted from Zhang 2013)

Climate policy in French mid-sized cities is marked by the use of planning documents and it is influenced by international and national guidelines. Although urban metabolism isn't yet used in many areas of climate policies, it could be explored at the local and regional levels as an answer to growing climate risks. Cities are not isolated entities, so understanding how they interact with their surrounding regions is a critical component in reducing urban ecological footprints and promoting environmental sustainability (Kennedy et al. 2011). Urban metabolism is an interdisciplinary approach to studying the sustainability of cities. As defined by Kennedy et al. (2007), urban metabolism is the *sum total of the technical and socioeconomic processes that occur in cities, resulting in growth, production of energy, and elimination of waste*. By understanding the dynamics of a city's resource flows, officials can understand how the city interacts with its surroundings and how different scenarios can impact these flows.

Initially a theoretical concept which applied to ecological energetics to urban energy flows (Odum 1971), scholars have expanded this theoretical framework into an array of more precise measurement tools (see Figure 2). The two most popular methods are material and energy flow analyses. These analysis tools enable researchers to model flows of consumption and production using quantitative data. Despite the growing literature on the benefits of understanding urban metabolisms, the lack of available data for computing the inflows and outflows of cities has limited its usage to larger metropolitan areas with enhanced accounting capabilities (Barles 2009). Though data availability is a limitation for urban metabolism calculation methods, the concept of viewing the city as a dynamic entity with inflows and outflows remains a potentially useful framework for understanding urban sustainability (UCLA Institute of the Environment 2009). Urban metabolism can provide insights into both the emissions and vulnerabilities of cities. Below are popular methods for modelling urban metabolism

Greenhouses are not evenly distributed across all urban spaces and the consumption of cities surpasses administrative borders (Blečić et al. 2014). For these reasons, the use of urban metabolism analyses can help to shed light on high emissions activities and areas. The design of cities and concentration of energy usage contributes to a phenomenon called the Urban Heat Island (UHI) effect. According to the United States Environmental Protection Agency (US EPA), cities can be more than 2-5 degrees warmer than surrounding rural areas (2021). This increase in temperature can be explained by the concentration of energy-intensive activities and infrastructure that absorbs solar radiation.

A metabolic framework can also demonstrate the causes and impacts of urban heat islands. Urban heat islands deteriorate the living conditions in the cities by inducing several impacts on their environment and inhabitants. Higher daytime temperatures and the occurrence of heat waves can increase energy consumption, impair water quality, and decrease the air quality. Most importantly, UHIs pose a serious threat to public health by increasing the risk of health-related diseases (such as strokes, heat exhaustion, heat cramps, and respiratory difficulties) and deaths. The populations most vulnerable are children, seniors, and immunocompromised individuals. In the United Kingdom, heat-related stress currently accounts for more than 1,000 premature deaths and 100,000 hospital visits per year (ARUP 2014). By conducting urban metabolism analyses, urban governments can gain insights into the urban processes and material flows which exacerbate the urban heat island effect.

PART 3

INTRODUCTION

As was determined previously, water is a critical resource at the core of climate change impacts in the French territory. It is crucial to examine the way it is governed to understand the challenges that mid-sized cities face in France. Similar to climate change policies, water in France is governed by international, national, regional, and local policies. Internationally, France is subject to directives imposed by the EU. These legal frameworks unite member states through common objectives while allowing the states to create national plans to tailor the directives to their own national contexts. Water governance in the EU has become increasingly decentralised, and most of the authority to govern French waters has been granted to the regional water agencies. Recent policies such as GEMAPI have delegated more power to local governments (Ministère de la Transition Écologique 2020).

There is a general need for a policy mainstreaming of environmental issues to respond to existing problems that will continue to worsen. Public management of water resources is a subject on which there needs to be a dialogue between the different administrative levels. The concern lies in the sub-territorial dialogue: how does the territory accompany sectors such as agriculture to adapt? The following section attempts to answer this question by studying the different levels of French water governance, an overview of which can be seen in **Figure 8**.

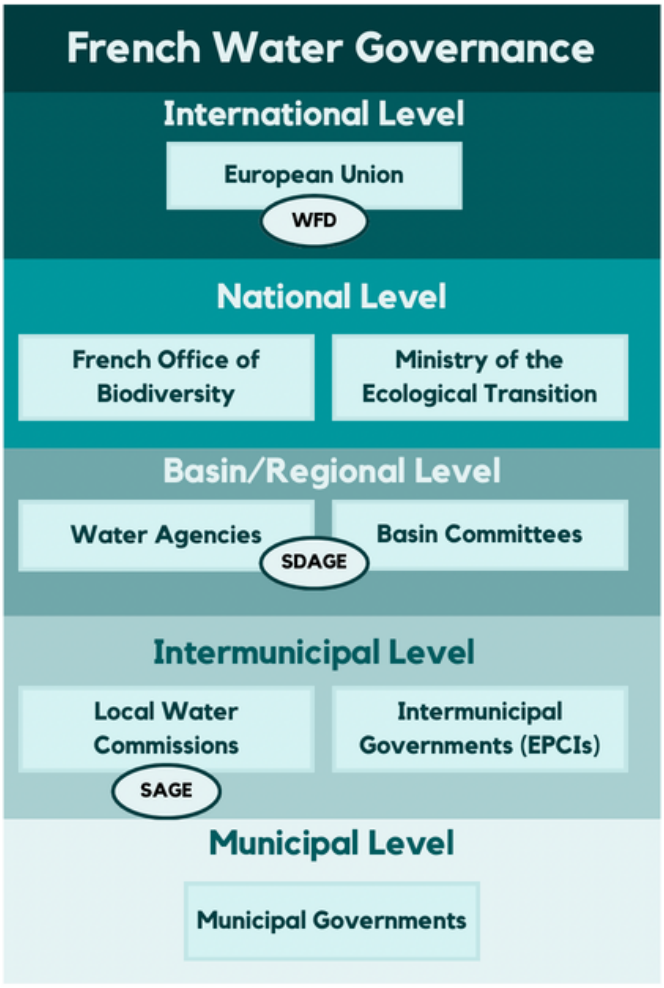


Figure 8: Overview of the different levels of French water governance

THE INTERNATIONAL LEVEL

Several EU directives have laid the foundation for French water governance. These include the Urban Wastewater Treatment Directive of 1991, the Water Framework Directive of 2000, the European Floods Directive of 2007, the Marine Strategy Framework Directive of 2008, and the newly-amended Drinking Water Directive of 2020. The following paragraphs describe these international guidelines and how they are translated at the level of France.

The **Urban Wastewater Treatment Directive** of 1991 aims to prevent negative impacts of industrial pollution on urban waterways. The directive set guidelines for the collection, treatment, and discharge of urban and industrial wastewater. By regulating the metabolism of urban wastewater, the directive aimed to promote a better management of wastewater across the continent. Today, approximately 90% of urban wastewater in the EU is collected and treated based on the guidelines of the Directive (European Commission 2019; European Commission 2020).

European water basins are governed by the **Water Framework Directive** (WFD) of 2000, which aims to protect the quality and quantity of water throughout the EU. The first aim of the WFD was a new water management based on river basins, which only slightly altered water management in France, because the country was already characterised by a long history of institutionalised river basin management prior to the directive being implemented (Jager et al. 2016). Following a policy evaluation, the EU ruled that the best model for a single system of water management was management by river basin - the natural geographical and hydrological unit - instead of according to administrative or political boundaries. Having this system already in place since the 1960s, France is considered one of the pioneers in water management. The economic binding nature of the directive was new in the field of water and strengthened the authority of river basin organisations: the basin committees and the water agencies. The directive also aimed at achieving "good status" for all waters, including surface waters and groundwater in addition to rivers and seas. This key element of the directive highlights the need for protecting aquatic ecosystems by reducing chemical pollution mostly caused by pesticides used in agriculture. The directive adopts a combined approach of emission limit values and water quality standards that must be implemented by all Member States. Finally, the framework includes proposals for citizen participation and streamlining of legislation.

The WFD requires that states create River Basin Management Plans (RBMPs) to meet the goals of the directive. In France, these management plans are called schéma directeur d'aménagement et de gestion des eaux (SDAGEs). SDAGEs are guidance documents that are legally bound and shape water policy at the basin scale. These documents contain regulations for water management throughout each water basin and are co-created by water agencies and basin committees. Water management plans at lower administrative scales, such as the SAGES (described in the following section) must take into account the regulations of the SDAGEs and are key for French local elected officials.

Flood prevention in Europe is governed at the international scale by the European Flood Directive of 2007. The goal of this directive is to provide guidelines for assessing and managing flood risks in member states. By making cohesive flood management plans, the directive aims to prevent negative economic, social, and environmental impacts of floods. Flood risks are managed in three stages by member states. In the first state, states must conduct a preliminary flood risk assessment to determine the areas of the basins which are most vulnerable to flooding. Next, states must map flood risks and the likelihood of flooding events. Last, member states must design flood risk management plans to reduce the impacts that floods will have on local communities.

The **Marine Strategy Framework Directive** aims to promote the health of marine ecosystems in the EU. Adopted in 2009, the directive requires member states to create national strategies for achieving resilient marine ecosystems. National strategies are revised every six years. In France, the agency responsible for implementing the directive is L'Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER). The national strategy includes reducing pollution, promoting marine biodiversity, and limiting eutrophication.

Drinking water in France is shaped at the international level by the EU Drinking Water Directive of 2020. Originally created in 1998, the Drinking Water Directive aims to promote the safety of drinking water throughout the EU. The directive was recently amended to introduce the requirement for states to focus on improving accessibility to high quality drinking water. Echoing the UN Sustainable Development Goal 6 which aims for sanitary and affordable drinking water, the Drinking Water Directive requires member states to enhance accessibility of water for vulnerable populations.

THE NATIONAL LEVEL: IMPLEMENTATION OF "SCHÉMAS DIRECTEURS"

At the national level, the actors governing water are the Ministry of the Ecological Transition, which sets the main national directives, and the French Office of Biodiversity, or *Office Français de la Biodiversité* (OFB), which was created in 2020 to replace the Office National de l'Eau et des Milieux Aquatiques, the central office of freshwater, and the Agence Française pour la Biodiversité. In some areas, SDAGEs designate threatened water bodies where extra local regulations need The main goal of these entities is to set procedures to implement the Water Framework Directive nationwide, standardising indicators and methods. Then, the Voies Navigables de France (VNF) manages navigable waterways under the supervision of the Ministry of the Ecological Transition. The VNF charges entities who pump or discharge water into public waterways in the country. The Grenelles I and II state the goal of improving water quality and eliminating hazards to fish migration.

The 1964 Water Act secured the creation of the system of water agencies (Agences de L'eau) and basin committees, which heavily rely on the schémas directeurs aforementioned that shape water policy at the basin scale. SDAGEs and the *schémas d'aménagements et de gestion de l'eau* (SAGEs) are regulated by the River Basin Planning and Concerted Local Water Management of 1992, which implies greater state control, with basin coordinators responsible for creating thresholds for activities and operations relating to water management and generating new competencies for the agencies. SAGEs, which must adhere to the basin-level SDAGEs, are created by local water commissions. These national documents set quantitative and qualitative objectives for local water bodies, allocate water quantities to different sectors, outline water conflict resolutions, and outline local water management and flood control (Centre Européen de Prévention du Risque d'Inondation 2022). SAGEs are policy tools which are created by local actors and require approval by the national government. All urban planning documents must adhere to the specificities outlined in SAGEs, which are thus essential to the articulation of water governance at different levels in France.

THE REGIONAL (BASIN) LEVEL

A. Water Agencies

In France, the regional level is synonymous with the basin level. As seen in **Figure 9** below, there are six main water basins in mainland France. These basins are separated into individual territories and are governed by water agencies, or agences de l'eau. Created by the 1964 French Water Act, water agencies have a direction board of elected officials deciding the main lines of water policies. Each of the agencies pursues different policies according to their local geography and water challenges, and a primary task is to deliver grants to fund projects in their respective basins. Many departments are split among two or three different water basins. Regions are usually located in a single basin with the exceptions of Bourgogne and Poitou-Charentes.

Figure 9: Map of water agencies in France (Richard, Bouleau, and Barone 2013)

The basin committees, or *comités de bassin*, act as a "parliament of water" ("Le Comité De Bassin" 2021). Members of the basin committees are appointed by the river basin coordinator to represent political local entities (i.e. regions, departments, municipalities), water users, and State offices. The committees are tasked with evaluating water quality and elaborating the SDAGE. The River Basin Coordinator is the Prefet who is responsible for the coordination of the actions of prefects of regions and departments. River Basin Coordinators are responsible for approving the River Basin Management Plans (RBMPs) and oversee the creation of regional Programs of Measures (PoM). These five-year programs are regional goals for water management based on national water policies. PoMs are funded by water agencies.

B. The Funding System

The funding of water-related projects by the Water Agencies is done by the users according to the division of the basins. The budget is self-sustaining: users pay for the water they use, which helps fund the infrastructure. The fees collected by the water agencies finance investments for water protection and operational management costs (AESN 2022). They also fund the establishment of a six-year management plan. Over the last period of the agencies' management programme (2013-2018), the overall budget of the water agencies amounted to 2.22 billion euros, and 712 million euros per year (AESN 2013). Agencies collect fees to eventually adjust consumer behaviour and lower water consumption.

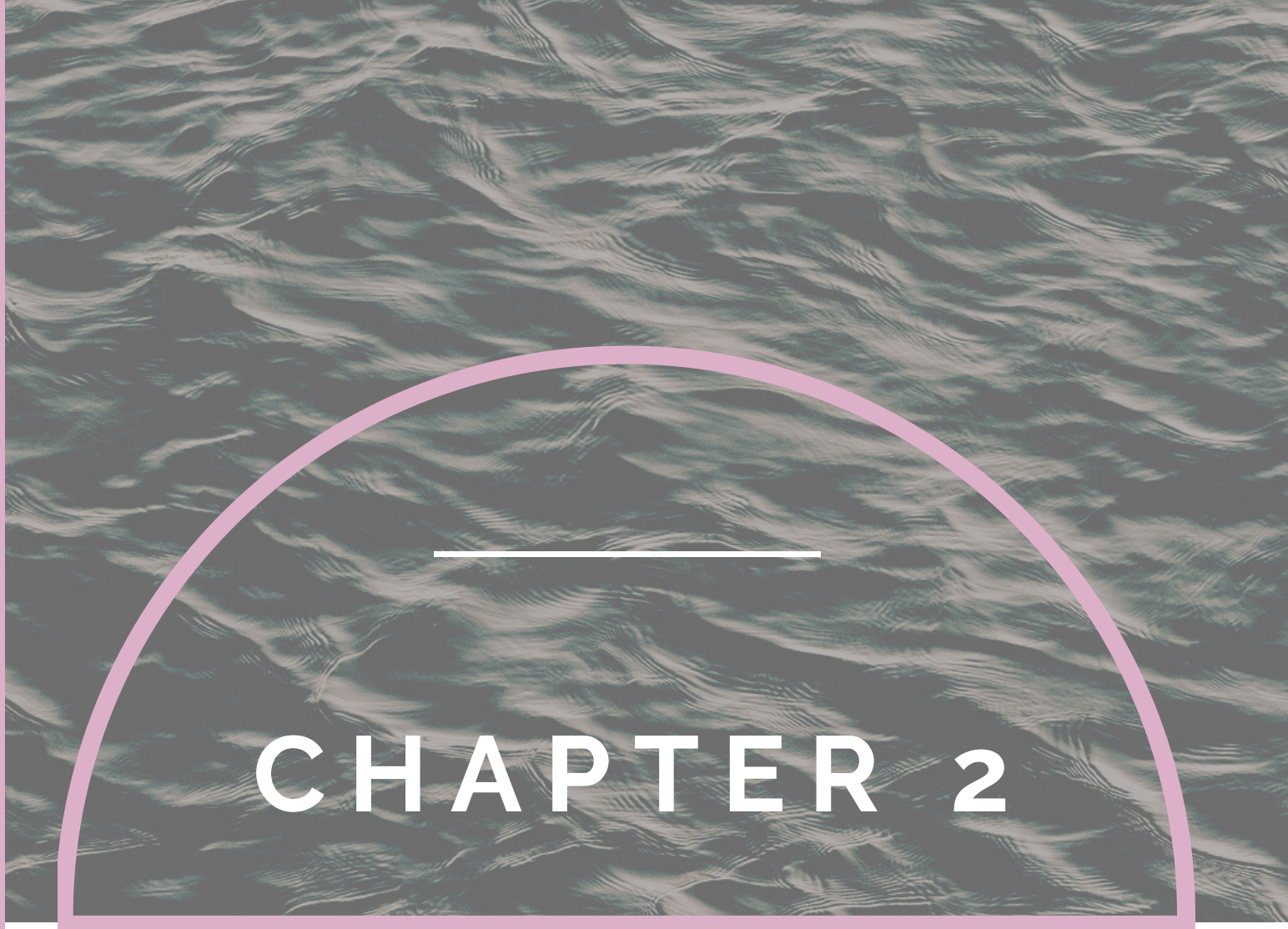
In this specific system, the resource and its funding are closely linked: water pays for water. It is through the billing of water consumption that the financial means are generated and used to maintain the water networks and management. However, this raises questions about climate change and the future of water management. The water budget may reduce the capacity to maintain facilities as it is structurally constrained by this billing system coupled with the current water consumption. This poses a structural issue in the water sector, as decreasing amounts of water would translate into less funding available for water agencies to implement water adaptation measures.

THE MUNICIPAL LEVEL

At the local level, municipal governments are responsible for the local implementation of water policies and plans, drinking water supply, local sewerage and wastewater treatment, and local water protection. Intermunicipalities (EPCIs) are responsible for flood prevention measures. In 2018, the legal competence of flood prevention, or la gestion des milieux aquatiques et la prévention des inondations (GEMAPI), was bestowed upon intermunicipalities. Regions and departments can continue to support GEMAPI projects if they desire, but are under no legal obligation to contribute. Previously, flood prevention was undertaken by various scales of government but no single scale was obligated to act. Regarding drinking water supply, the Water Act of 2006 confirms the municipal jurisdiction in terms of drinking water supply. This competence has previously been an optional duty for municipal governments.

The local governments, or collectivités territoriales, are administrative institutions separate from the State administration, which supports the interest of a specific territory. They include regions, departments, and municipalities. The municipalities are the only political institutions with jurisdiction over water. There is no assigned compulsory jurisdiction regarding water to Regional or Department governments. However, both levels of government dedicate revenue to water issues.

The key actors at the municipal level are the local water commissions, which create local water management plans (SAGE) and local objectives and appropriate regulations. The members are the State representatives (maximum of 25%), water users (25%), and local elected representatives (50% minimum). Local water commissions are active in wastewater and stormwater treatment, as well as in the supply of water. This management can also be delegated to private companies or intermunicipal cooperatives such as intermunicipal syndicates.



CHAPTER 2

WATER AND CLIMATE CHANGE GOVERNANCE CHALLENGES

PART 1

MEETING EU TARGETS

As described in Chapter 1, water-related stress is perceived in many areas in France in the form of scarcity, sea level rise, floods, intense rains and pollution. Climate change exacerbates these threats and the future challenges that public authorities must handle. In Europe, the most prevalent natural disaster is floods, and the human and capital cost of preventable water-related accidents is very high (Koop and van Leeuwen 2017). As a result of these threats, the European Commission passed the aforementioned Water Framework Directive in 2000.

Since 2000, the WFD has gone through two cycles of progress reports and has been improved through amendments, including a Floods Directive that requires Member States to assess areas at risk of flooding and an Environmental Quality Standards Directive that identifies priority pollutants that States must eliminate to protect the aquatic environment. According to the latest report on the implementation of those directives, howevernone of the river basins in metropolitan France have completed all the measures that were due in 2021 (European Commission 2021). Most of the basins have reported improvement from the first cycle in terms of water quality standards, but they were not sufficient to reach the numerous objectives set by the EU. France is not the only country in this predicament; none of the Member States achieved all of their goals. In the Rhône basin, where Bourg-en-Bresse and Arles are located, and the Loire basin, where Saint-Nazaire is located, very few of the objectives were met despite the waters becoming closer to reaching the "good status" demanded by the EU in the second cycle. **Figure 10** below shows how the Rhône and the Loire compare to other French basins in the achievement of the EU goals.

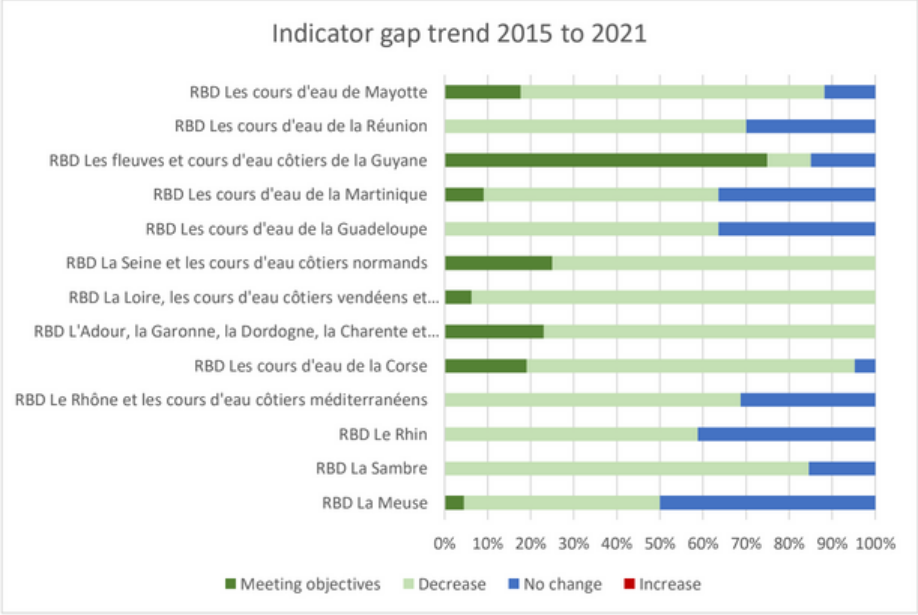


Figure 10: Trend in indicator gap 2015-2021 reported for the implementation of planned Programme of Measures (European Commission 2021)

THE GOVERNANCE CAPACITY FRAMEWORK

The Rhône and the Loire, along with all the other French basins, face four types of obstacles that hindered the change necessary to reach the EU targets: governance, delays, lack of finance and lack of mechanisms. These challenges echo the conclusions drawn from studies by the OECD (2016) on water governance in cities, which highlighted the largest issues as institutional fragmentation, ambiguous legislation, poor implementation of multi-layered governance, as well as matters such as limited capacity at local level, unclear allocation of roles and responsibilities, fragmented financial management and uncertain allocation of resources. The OECD concluded that building adequate governance capacity in water management was a premise for the sustainable future of cities. According to an article published in Climate Law, the governance capacity advocated for by the OECD refers to "the degree to which a public-private network of actors is able to resolve societal issues, in particular, climate-adaptation issues" (Mees and Driessen 2011). Governance capacity can be divided into five subcategories visible in **Figure 11**: legal capacity, managerial capacity, political capacity, resource capacity, and learning capacity. In order to understand the reasons why France is not meeting the water objectives set by the EU, this chapter will focus on the five subcategories of governance capacity to uncover the particular challenges faced by mid-sized French cities.

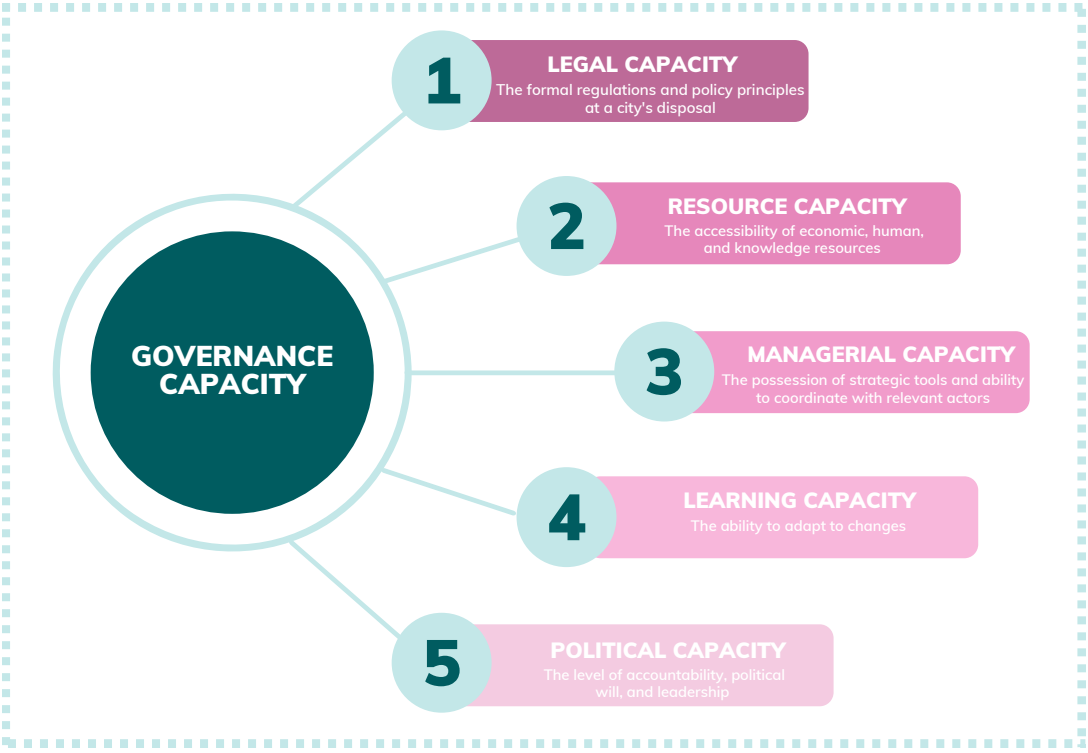


Figure 11: The five components of governance capacity (inspired by Mees and Driessen 2011)

Focusing on the case studies analysed in this report, Chapter 2 will examine the potential contradictions in water policies of the Rhône and Loire basins as well as the municipal policies of Bourg-en-Bresse, Saint-Nazaire and Arles. Is there a sense of urgency at the local level to address water and climate related issues? Are there any multi-level governance gaps as identified by the OECD? Is there multilateral coordination to implement climate policies? Are the margins of manoeuvre adequate for the various stakeholders with regards to the magnitude of the stress observed in Chapter 1? Chapter 2 will answer these questions by using the governance capacity framework developed by Mees and Driessen (2011) and laying out the challenges observed for each subcategory related to water governance. The interviews performed with major stakeholders in all three cities and regions helped to paint a clearer image of who perceives water-related stress the most and the main governance challenges of cities. Backed by academic literature and interviews, Chapter 2 helps illustrate the challenges of climate governance for mid-sized cities in France.

PART 2

The Governance Capacity Framework

Governance capacities : Legal, Resource, Managerial, Learning, Political

Legal Capacity

Resource Capacity

Managerial Capacity

Learning Capacity

Political Capacity

Tool inspired by Mees and Driessen 2011

LEGAL CAPACITY

In the governance capacity framework, the first category is the legal capacity, or the formal regulations and policy principles that municipalities have "at [their] disposal to steer adaptation planning" (Mees and Driessen 2011). As the authors explain, these rules can be used for the protection and use of resources like water. The assumption is that the more numerous and stronger these rules and policies are, the higher the legal capacity to adapt the urban environment to issues such as excessive rainfall. At the level of the mid-sized city in France, actors from the French water sector mentioned the low legal capacity of the municipality itself and referred to the level of Établissements Publics de Coopération Intercommunale (EPCI) as the ideal level to implement appropriate regulations and policies. This first part of Chapter 2 will thus analyse the advantages as well as the limits of legal capacity of local water governance in French cities and what they illustrate about climate governance as a whole.

A. Decentralisation and the Role of Cities in Water Management

As was discussed in Chapter 1, France has been decentralising its competences since the 1980s. It is the application of the principle of subsidiarity in the decentralisation discourse — according to which the lowest possible governance level apt to execute a given competence must execute it — that implies giving municipalities more legal power. However, legal competences cannot always be executed effectively at the municipal level of governance. If different governance levels are not able to communicate effectively, then decentralisation can play to the detriment of the simplification of governance mechanisms. Breaking down competences is an effective governance move if slightly different criteria are followed. For example, instead of following administrative frontiers of governance, some actors that were interviewed proposed following geographical frontiers of governance. This is already the case for France, where basin governance bodies were established early in the history of water governance (Jager et al. 2016). In the basin context, water agencies are the actors linking the national and the local scales.

The legal role of water agencies and agglomerations should be empowered. Experts in the sector advocate for this point, as the creation of more agglomerations and EPCIs expands the legal influence of municipalities. It allows municipalities to have their own competences, thus emphasising the importance of the 'local'. Most importantly, the creation of more agglomerations and EPCIs facilitates the merging of a municipality's legal competences with other municipalities' legal competences, thus strengthening the legal power of such competences.

B. Legal capacity and transboundary climate risks

Municipalities have low legal capacity in relation to water management. According to most stakeholders interviewed, from regional agencies like the ADEME to representatives of the agglomerations like the CARENE in Saint-Nazaire, the most important way in which municipalities can address climate related challenges is in EPCIs. Several interviewees stressed that the ecological transition happens at the intermunicipal level, sometimes even more than at the level of the department, deemed too large by some, or the municipality, deemed too small. EPCIs are especially important because they bring smaller municipalities together, thus giving them more power when interacting with key stakeholders such as the Agence de l'Eau. For example, in Saint-Nazaire, where actors from the water sector have mentioned that water is the most pressing environmental issue, the intermunicipal agglomeration of the CARENE has worked on building a dyke to protect the population from sea level rise. EPCIs recently acquired the competence of management of aquatic ecosystems and prevention of floods (GEMAPI), so municipalities affected by sea level rise highly benefit from joining forces with other agglomerations by acquiring more legal capacity. In Bourg-en-Bresse, actors have emphasised the importance of this new competence that allows municipalities to implement payment fees for flood prevention.

According to an analysis of the Rhône river basin management, the river basin level (Aubin et al. 2019) is the most apt level of governance to deal with transboundary water-related risks. This is because the Agences de l'Eau, operating at the basin level, have a more systemic view of the water cycle in a region. Climate risks result from cascading impacts transmitted across sectors and administrative borders: they are transboundary (Challinor et al. 2018).

Therefore, municipalities cannot adapt to all the risks coming from other areas if they do not make considerable efforts to work with other actors. The key to the governance of transboundary risks is the collaboration between different levels of governance: basin and municipal. The water sector is related to many other sectors such as agriculture, which according to an interviewee from the French Ministry of the Ecological Transition is the largest contributor to water scarcity and water pollution.

It is estimated that agriculture accounts for 92% of the global blue water footprint (Hoekstra et al. 2012). Livestock also significantly contributes to humanity's water footprint, water pollution and water scarcity (Jalava et al. 2014; Hoekstra 2014).

These findings may explain why certain local elected officials have expressed a lack of legal capacity to have an impact on water-related issues and to reach the EU-mandated targets. Local actors from the CARENE have mentioned the difficulty of dealing with intense localised rainfalls due to their unpredictability and the path dependency of the built environment of a city. Adapting to sea-level rise and unpredictable rainfalls requires planning years ahead, which can be difficult for local authorities. The interviews conducted with actors from Saint-Nazaire, Arles and Bourg-en-Bresse showed that elected officials are often left prioritising short-term plans over long-term ones due to a lack of agency and impetus, which negatively impacts the adaptation to climate change.

As this first section demonstrates, water-related stress is already felt by local elected officials and by actors at the scale of the EPCI. Despite the importance of working with other agglomerations to gain legal capacity and the crucial role of urban planning in adapting to climate change, municipalities are struggling to protect their populations from floods and keep up with EU-mandated water quality standards. This is can be exacerbated by a lack of perspective on the future of water-related issues and a lower legal capacity.

RESOURCE CAPACITY

Mees and Driessen (2011) define resource capacity as economic, human, and knowledge resources that policy makers have at their disposal to deal with climate change adaptation. Resource capacity is regarded as a critical factor in the literature on adaptive capacity and also in urban green planning, which relates to permeability of soils and floods (Gupta et al. 2010). Funding is a necessity for any climate change policy, but the available knowledge and the support of internal and external experts are also crucial in light of the uncertainty of climate change. In order to examine the governance challenges related to resource capacity, this second section of Chapter 2 will focus on each of the resources defined as critical by Mees and Driessen (2011).

A. Economic Resources

As previously shown, the role of the Agences de l'Eau in the governance of water is critical because of the transboundary nature of climate risks. River basins bring many actors together, including local elected officials, to manage water related risks within geographically relevant boundaries. French water agencies are a public entity under the scope of the Ministry of the Environment. They collect money through "redevance" fees (fees for service) that are paid by water users based on their consumption and how much they pollute. **Figure 12** in the next page shows the share of user fees paid to the Agences de l'Eau, where households are the largest contributors to the fee. Water agencies then use this money to help the users financially and by communicating on climate and water related risks. Since 2020, however, the State has implemented the principle of the "plafond mordant," thus creating a threshold of funds collected from the tax over which the water agencies have to give the money to the State. Interviewees have mentioned that the Agences de l'Eau are subject to fierce financial constraints that are hindering the work they do to protect biodiversity and anticipate water-related risks. According to an interviewee from the Ministry of the Ecological Transition, there are not enough payment fees (or taxes) being implemented to promote environmental protection projects, which could be one of the reasons other interviewees in the water sector reported a lack of financial resources to anticipate water-related risks.

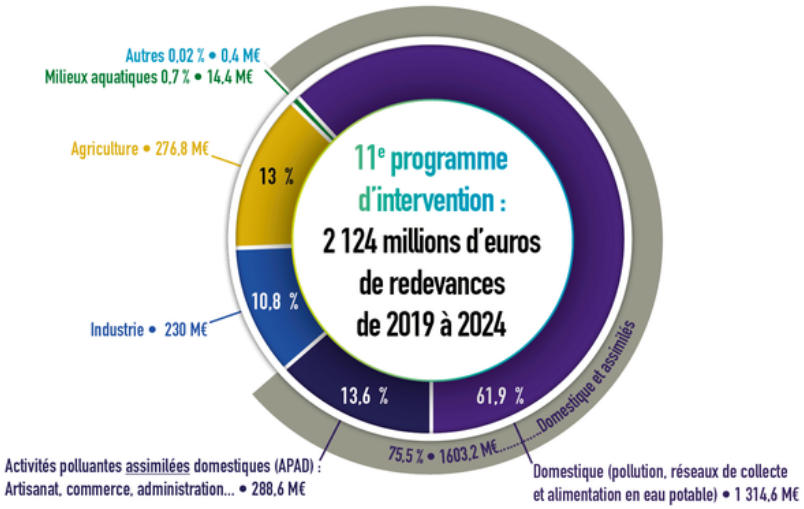


Figure 12: Contribution to the water budget of different entities (Agence de l'eau, Loire Bretagne 2019)

Companies can also be an important actor in the fight against climate change and particularly to improve flood resilience, which was shown to be a major challenge for mid-sized cities. The private sector can contribute to flood risk governance through public-private partnerships when public and private actors have aligned interests and cooperate (Driessen 2018). However, according to an interviewee from Saint-Nazaire, many public-private partnerships do not necessarily lead to environmentally-sustainable behaviors since companies are not always often regulated or incentivized to follow guidelines regarding sustainability goals. For companies which strive to protect the environment, Commerce chambers are a great resource to guide them. An interviewee from the CCI of the Ain region highlighted that "more and more companies are starting to work towards energy efficiency and reducing their water consumption". However, even though the State gives financial resources to the CCIs in France, companies are not required to ask for their help. Moreover, the public-private partnerships in the water sector have not been able to make up for the reduction of public engineering (Barone et al. 2016) in the drinking water and sanitation sectors because of absence of aid from the State. The 2008 reform gave space for the private market to take over but has not gone as smoothly as expected. The private sector did not take over the financial responsibilities of the State, thus leaving EPCIs with growing responsibility but the same budgets.

B. Human Resources

Mid-sized cities do not have as many human resources as larger cities and State entities and are lacking the appropriate staff trained in specific climate change and water questions. Hence the importance of the EPCIs, where municipalities can pool resources and better anticipate climate risks, as well as respond to their staff needs. In the water sector, the Agences de l'Eau are also crucial, having human resources exclusively dedicated to helping policy makers manage water and its risks. However, interviewees still reported too little human resources working at the EPCIs scale, which is in charge of flood prevention. Floods are the largest natural disaster many mid-sized cities face, so this poses a crucial threat for policy makers.

MANAGERIAL CAPACITY

Managerial capacity refers to the ability of local governments to coordinate with other actors to achieve common goals (Agarwal et al. 2021; Mees and Driessen 2011). According to Mees Driessen (2011), the managerial capacity is one of the most crucial governance capacities to ensure a successful water governance and environmental transition. Public authorities need to coordinate the different levels of governance and their technical expertise to limit policy compartmentalization and institutional fragmentation, which are two barriers observed limiting governance efficiency.

Coordination Challenges

Coordination between entities of water management and governance is still fairly limited and "institutional fragmentation" has been identified by the OECD (2011) as a "governance gap" in water governance. Water is a natural resource that flows independently between geographical zones and governance tiers. Water governance, equally as climate change, would benefit from a more cross-cutting approach with better coordination and collaboration between the different actors and stakeholders involved, as well as the other policy sectors that are linked to its management (Simon and Leck 2012). To achieve this, cities need to enhance their vertical and horizontal coordination, which they are currently lacking according to interviewees.

Despite the implementation of the Water Framework Directive (WFD) in 2000 which implements a cross-sectoral approach, the governance tradition of dealing with water by narrow sectors has left a legacy and is still too often employed (Rasul et al. 2021). This can lead to the compartmentalization of public action and fragmentation of information, as our interviews revealed. This lack of coordination in water governance can lead to loss of time and resources, and thus efficiency, as competences and actions are sometimes ill-defined between actors. This is particularly critical in water management, which has a complex organization with shared competencies. Actors note that there is no need for new governance arrangements, as there are enough levels and institutions. Instead, they suggested that there needs to be more coordination to link actors together.

In water governance, a lack of policy coherence generates a confusion in the actors and their water competences. A water governance actor in Saint-Nazaire, for example, suggests that more cooperation and information exchange between administrative levels would facilitate the creation of unified strategies. The actor added that the lack of communication and coordination between administrative bodies can result in the repetition of actions.

The water governance arena is composed of public and private actors, institutional bodies from different levels of governance as well as less formal actors such as civic society and associations, all of which are connected through cross-sectorial intermediate bodies that foster coordination and co-working (ex. the Agences de l'Eau). Civil society also needs to be integrated through horizontal coordination and partnerships to achieve more satisfying coordination results and manage cooperation (Brinkerhoff 1999). This is also the case for the private sector that can collaborate with other policy sectors and foster knowledge exchanges and policy coherence through public-private partnerships and integrative management tools (Mees and Driessen 2011).

Geographical coordination enables to bring together all the actors of the water cycle and circulation and use the natural boundaries of water bodies of public actions: "They create incentives for social linkages between actors who use the associated resources" (Bodin and Tengo 2012, 366). This creates more coordination and better flexibility, communication and solidarity between the actors and the scales of action that would normally work independently, as one interviewee said. By having a more global vision of the natural phenomena of water, such as ice melting, river flows, source points; decisions makers are better informed about the intertwined cascades of event loops that occur in water ecologies and can come up with more adequate strategies.

Thus, increasing the intensity of interactions and connections between governance entities is crucial, as "the level of coordination across policy sectors, governance levels, and geographical areas influences the effectiveness of planning - the more horizontal and vertical coordination, the better" (Mees and Driessen 2011, 251). This also translates into less policy fragmentation. To achieve that, informal personal exchanges and trusted relationships between actors are also needed (Wolfram 2021). Yet, more in depth solutions will be analysed in Chapter 3.

LEARNING CAPACITY

The learning capacity of public powers is the continuous learning process of exchanging information and dealing with uncertainty, which is at the core of climate change. Learning is intrinsically linked to communication and knowledge diffusion amongst the different layers of government, which needs to be improved. Literature research and interviews suggest that public authorities' capacity to learn is critical in topics as challenging and technical as water management and climate change. It is not merely about the addition of experts in municipalities, but about questions of formation and education. In other words, by making non-experts experts in the realm of water governance in mid-sized cities. Developing stronger pedagogical skills enables authorities to also develop their adaptive capacity, or the "adjustments in natural or human systems in response to actual or expected climate stimuli or their effects, which moderate harm or exploit beneficial opportunities'' (IPCC 2014, 6), which is critical to face the challenges of a changing climate (Mees and Driessen 2011, 251).

A. Coping with Uncertainty

The learning capacity of a city's public authorities is the continuous learning process of dealing with uncertainty and adjusting to change (Pahl-Wostl 2009), which is at the core of the environmental mutations. Crafting future water policies in a changing climate is particularly difficult because of a double uncertainty lying both in the difficulty to predict the future aspect of climate change and environmental but also the uncertainty in the governance and decision-making process of this unprecedented global challenge. Dewulf and Biesboerk (2018) also point out the multiplicity of the unpredictability of climate change governance: it is institutional, as laws and political decisions might change; behavioural, as incentives of actors can also not be predicted; and scientific, as the future evolution of the highly complex Earth system cannot be completely mapped out. Many political and environmental variables need to be taken into account and the financial assessment of environmental policies tackling future events is also difficult to determine (Gramelsberger and Feichter 2011).

Adaptive governance requires learning how policies work in complex multi-actor systems of governance and diffuse this knowledge (Muluk and Hermans 2008). As Muluk and Hermans (2008) explain, policy learning in water governance currently mainly follows accountability strategies but leaves theory-oriented learning out. The latter focuses on the specificity of the local context and the constellation of actors involved in governing water. Yet, understanding local contexts and local actors matters.

Despite still lacking in mid-sized cities, learning capacity is pivotal for successful water management: "The greater the extent of existing infrastructure for the distribution and safeguarding of knowledge, the greater the exchange of experiences facilitated through internal and external networks, and the more frequent the utilisation of stakeholder dialogue to enhance learning, the higher will be the learning capacity" (Mees and Driessen 2011, 257). Stakeholder dialogue and knowledge exchange seem to be key. Information diffusion can take many forms that are insightful for water governance: technological approaches, theoretical knowledge, and understanding of the catalysts of societal change.

B. Knowledge and Information Sharing Challenges

Knowledge of practical experience and climate change is also important for adapting to water threats and protecting populations (Mees and Driessen 2011). For urban planning to be effective and account for future challenges, municipalities need to be aware of the specific risks they will face in the future. Institutions such as the IPCC produce significant amounts of knowledge on mitigation and adaptation measures, but interviewees have reported feeling overwhelmed with the amount of knowledge available. Entities like the Ministère de la Transition Ecologique and the Direction Régionale de l'Environnement, de l'Aménagement et du Logement help local elected officials understand the key aspects of research on climate change, but because there so much information available, it can be difficult for policy makers to sort out the most important findings for governing the water sector.

Expertise in technical sectors is lacking in smaller towns, as they are concentrated in larger cities. An interviewee from the national level noted that because water is seen as a very technical and scientific sector, policy makers tend to overlook it for lack of knowledge. Other interviewees from the water sector have explained that it is more about the difficulty in deciphering where to get knowledge and which is most important, because of the sheer volume of scientific articles published every year on the topic of water and climate change.

Moreover, the complex administrative "millefeuille" requires more communication between the levels of governance, which can become a challenge impeding the efficient flow of information (Bernard 2007). That has also been backed by numerous interviewees in different professional positions complaining about the lack of information structures in the French bureaucracy for rapid and clear communication. Intermediate bodies of governance can serve as information relays between the government tiers.

Communication and information sharing also need to target citizens to include them, as educating the population that will be impacted by a policy and urban development can promote a greater success of its reception, and thus application (Brody et al. 2011). However, many interviewed actors noted that knowledge diffusion between the local and citizen level and national government is still not so effective. Understanding the application of directives on the ground with citizen engagement is an essential ingredient for the creation of sensible and coherent policies, as "Dialogue between decision makers and local inhabitants is a prerequisite for sustainable urban development" (Enyedi 2004, 18). The problem is not a matter of availability of information, but how to target citizens with effective communication.

POLITICAL CAPACITY

Water governance involves different levels of governance which each hold political capacity and impetus of the ecological transition. Political capacity is composed of two factors: first, it is the accountability of public authorities and their political will to implement the transformative environmental actions needed. A strong political vision from officials sets the pathway for structural change and gathers societal support.

Secondly, it is also the leadership in a multi-level governance as well as supporting the actors in the water transition. This report focuses on cities, but the municipal level is also at the interplay with the national and its guidelines and policies. In both cases, strong commitment of governments in their political capacity is essential as "policy responses will be viable only if stakeholders are properly engaged" (OECD 2022, 4).

A. Political Vision

By following national legislation, cities reflect the political vision of the national governments in water management; power and agency also lay in the performance of future visions (Avelino et al. 2016). Yet, a lack of strong vision and leadership from above seems to be hampering the impetus of municipalities to implement significant change. More precisely, the lack of a systemic vision where all policy departments are cooperating and involving the environmental question has stemmed from our interviews as a crucial hurdle in governing a successful ecological transition.

The environmental political vision also needs to be grounded amongst the municipalities and local authorities that are progressively setting up their climate strategies, such as the 'Plan Energie Air Climat': one elected official noted that long term plans are especially in need of a political vision that can be cross-cutting and go beyond the temporality of political mandates.

Another point of articulation that can be challenging in the political vision is the dephasing between national policies and the local ground. The long-term goals need to be shared amongst the levels of government with a coherent future picture for the long term together. Yet, the local stakeholders in water point out a limited involvement in the early stages of crafting a long-term vision (Avelino et al. 2016).

B. Lack of Vertical Support

For efficient results in sustainable water management, all layers need to coordinate and answer to their competences.

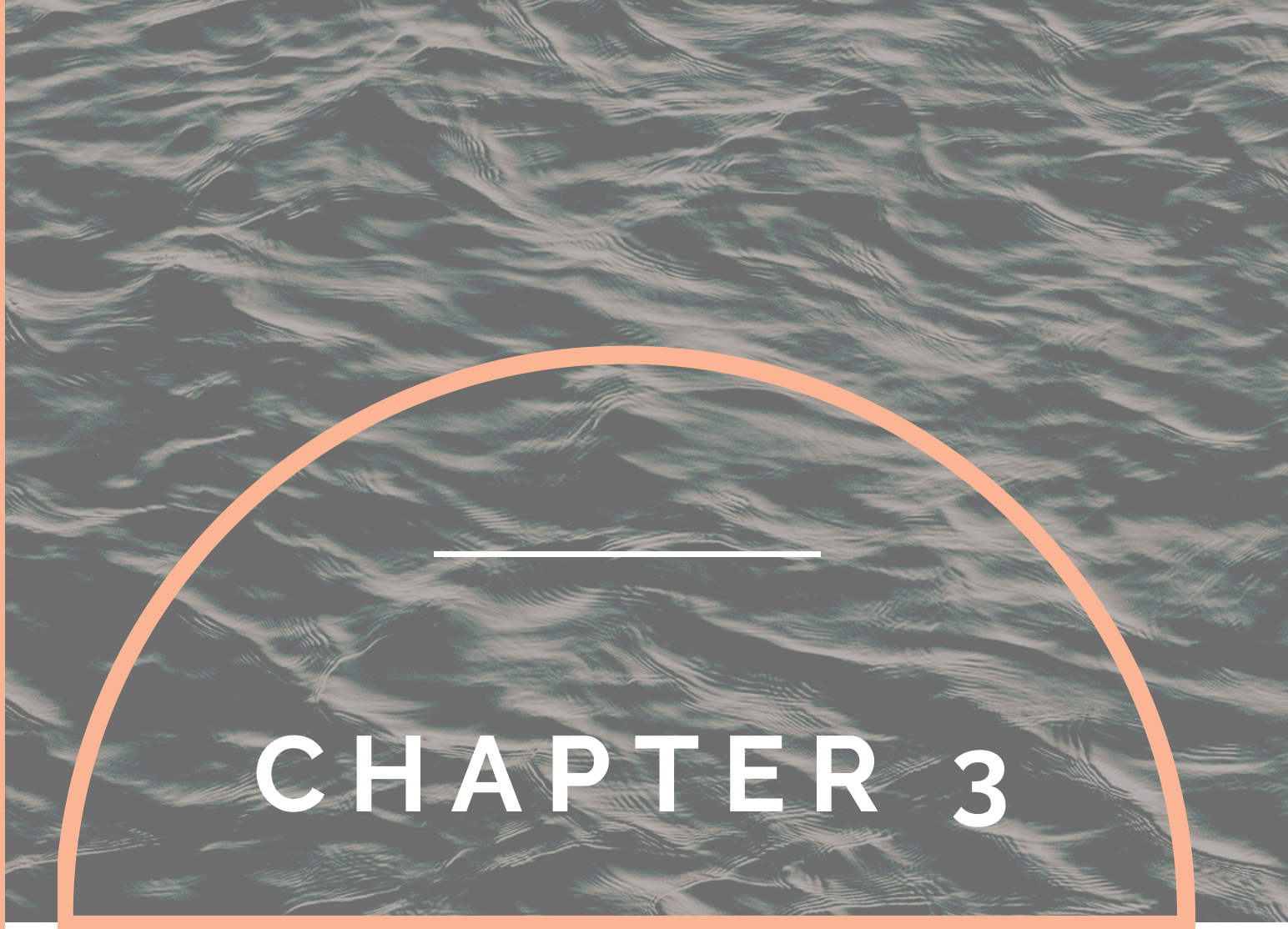
The role of the national powers is to lead and ensure policy coherence of the lower levels of government: "The stronger the leadership, the higher the political capacity of city administration to promote change" (Mees and Driessen 2011, 251).

After crafting together a political vision and goals for every actor in the water sector, accompaniment of the lower levels of governance also needs to be ensured. As was pointed out in several of our interviews, vertical support between public authorities can be inadequate and there can be a disconnection between the state administration and the local reality of cities. A lack of common understanding is hampering the transfer between national guidelines and their efficient implementation on the ground: an elected official stated, "the national has to learn to speak the languages of the territories and their specificities, and we need to listen as well". "Local resonance" is needed if cities are to become the municipal relays of national action. Territorial specificities are also essential in water governance as the natural resource is tightly linked to its climate, geographical context, and human consumption: "Context matters for transitional politics" (Avelino et al. 2016, 557). A hypothesis formulated by an elected official in Bourg-en-Bresse was that the weak echo between the different layers of governance is also due to a concentration of knowledge and power in restricted geographical zones such as the capital city or greater metropolises which limits the capacity of national decision makers to understand smaller cities.

Citizen engagement is also a central component for the smooth vertical support of policies from their national crafting to their very local implementation. Mees and Driessen hypothesise that "the more active engagement there is from stakeholders and the public, the higher the political capacity of city administrations will be" (2011, 251). Awareness actions amongst the local audience and participation of all relevant stakeholders, including citizens, ensures a good reception of water strategies but is still lacking today. Otherwise, ecological guidelines from the top powers can be perceived as sanctions in the cities, which is something that came up in our interviews.

Conclusion

Cities are facing struggles to answer water challenges induced by climate change and are failing to meet their policy targets. Governance limits seem to be at the root of setbacks as cities, especially mid-sized ones, need to concentrate their efforts on improving their political, resource, legal, learning, and managerial capacities. The greatest potential for manoeuvre and efficiency gains in governance appear to be in the legal and political capacities, which can have the strongest results (Mees and Driessen, 2011). As the chapter demonstrates, structural and decisional hurdles are slowing down the public process of the ecological transition and of better water management. Managerial, learning and resource capacities are also challenged and have potential for improvement.



CHAPTER 3

PROPOSED SOLUTIONS TO GOVERNANCE CHALLENGES

INTRODUCTION

As demonstrated in the previous chapter, French mid-sized cities struggle to gain the governance capacity to effectively address climate change at the local level and help France reach the objectives set by the EU. This can be attributed, in part, to a lack of financial and administrative support from the national government. A general solution to this problem is to decentralise technical expertise and financial support. This can occur by providing technicians and local experts with fundamental training on the impacts of climate change. However, Chapter 3 aims to go beyond this simplistic vision of local vs. national governments by providing a wide array of solutions for increasing governance capacity in each of the five subcategories. The following solutions are proposed for implementation by local actors and they also require multilateral collaboration and support. Solutions are organised to respond to the challenges described in Chapter 2.

As seen in Chapter 2 and in the page below, the framework of governance capacity describes the five capacities related to governance - in which governance capacity is defined as the "degree to which a public-private network of actors is able to resolve societal issues, in particular, climate-adaptation issues" (Mees and Driessen 2011, 253). These are: legal capacity; managerial capacity; political capacity; resource capacity; learning capacity. In the context of Mees and Driessen's study, urban greening, legal and political capacities are considered to be very strong capacities. In contrast, resources and learning capacities are considered weak, but offer potential for improvement. Finally, managerial capacity is considered controversial as it is constrained by compartmentalization and institutional fragmentation (Mees and Driessen 2011, 251).

PART 1

The Governance Capacity Framework

Governance capacities : Legal, Resource, Managerial, Learning, Political

Legal Capacity

Resource Capacity

Managerial Capacity

Learning Capacity

Political Capacity

Tool inspired by Mees and Driessen 2011

LEGAL CAPACITY

A. Contextualising and Localising National Policies

By legal capacity, the report refers to formal regulations and policy principles at the disposal of municipalities. These can be derived from national laws or regional directives which municipalities adapt to their local contexts. As discussed in Chapter 2, one big issue is understanding national laws and guidelines at the local level. It can be challenging for municipalities to translate national laws so that water directives and policies are concretely implemented at the local level. Municipal governments can direct city-specific questions to their respective water agencies, who are in charge of this translation across levels of governance. By clarifying their needs to water agencies, the latter can translate national guidelines in a way that highlights and respects the specificities of a given municipality. In turn, local responsibilities towards water management can be confirmed by engaging with members of basin committees and water agencies.

B. Urban Planning

As identified in Chapter 2, one of the main urban challenges related to water is the absence or deficient state of water infrastructures. Urban planning as a legal tool can be deployed as a response to this issue (Mees and Driessen 2011). As urban planning regulates land use, it can regulate the use and creation of green and blue spaces. The implementation of blue-green infrastructure is a useful tool that mid-sized cities can use to adapt to climate change. According to Dolman and O'Connell (2021), blue-green infrastructure refers to "the use of blue elements, like rivers, canals, ponds, wetlands, floodplains, water treatment facilities, and green elements, such as trees, forests, fields and parks, in urban and land-use planning."

To give a few examples, the protection of existing green spaces and the implementation of new ones allows the city to face multiple climate challenges. The creation of green islands and green roofs can protect the city from heat waves. A second benefit of having green areas is the mitigation of flooding. As greenery expands in urban areas, soils are more permeable, absorbing rainfall and wastewater, thus making the city less vulnerable to floods. Following this solution, many major European cities are replacing tiles, streets, asphalt with flowers, plants, and similar (Mees and Driessen 2011). For example, Paris is a city vulnerable to flooding where many plans have been put in place to green the city. One among many is the construction of an urban forest in Place de Catalogne (Dufau 2022). Another example is the municipality of Nantes, which has been substantially greening the city in recent years (Garcia-Lamarca et al. 2021).

Another example of green-blue infrastructure can be found in the Netherlands, which has been dealing with flooding issues for years. Specifically, the city of Rotterdam aims to become 100% climateproof and waterproof "to ensure that each specific area is minimally disrupted by climate change both then and throughout the following decades" (Oppla 2022). In addition, with a mix of paving and vegetation, the aim of Rotterdam is to implement adaptive measures "whereby rainwater is captured and drainage is delayed" (Oppla 2022). Another example is the restoration of the canals of Milan, known as 'navigli', which now feed a substantial number of agricultural lands just outside the Italian city (Città di Milano 2022).

RESOURCE CAPACITY

A. Increased Funding

In this report, resource capacity is measured by the degree of accessibility to economic, human and knowledge resources. To enhance resource capacity, a straightforward solution to the issues raised in Chapter 2 is the implementation of more funding for municipalities. Interviewed elected officials mentioned that this would be particularly beneficial for mid-sized cities. Smaller cities may not have the financial means to undertake large-scale adaptation projects or to incorporate environmental consciousness on top of their political agenda.

Engaging in public-private partnerships (PPPs) is a solution to gaining funding and administrative support for implementing climate adaptation measures. Literature and interviews have demonstrated that PPPs can provide municipalities with access to financial resources and human capital. In all the three municipalities chosen as case studies, local *Chambres de Commerce et d'Industrie* (CCIs) played a collaborative role in water governance. CCIs are public bodies that mostly collaborate with private enterprises. In recent years, CCIs have expanded their sustainability action plans and have placed a greater focus on water issues by providing companies with support to implement their local environmental plans.

B. Regulation of Public-Private Partnerships

While PPPs can be useful tools for municipal governments, strong regulations by public bodies are critical for ensuring private stakeholders integrate climate adaptation measures to tackle water-related issues. Although interviewees from the public sector have mentioned the benefits of PPPs, they have also highlighted the issues the lower level of regulations that they are subject to regarding the environment. Although CCIs can be very helpful for companies, the latter are not required to seek out advice on climate measures. Making it mandatory could alleviate some of the burden of making the ecological transition from municipal actors.

Secondly, PPPs can also be a hinderance to an effective and just transition, as in the case of the privatization of services like water. For example in Barcelona, where water has been managed by the company AGBAR for decades (March 2019), citizens have suffered from low water quality and high prices. In such instances, a remunicipalisation of the service has been advocated for by activists and NGOs to protect citizens from rising prices.

Although the city of Barcelona has faced a lot of complex and path-dependent obstacles for the remuncipalisation of water, other cities have had more positive results. In Cochabamba, Bolivia, local protests against the partnership between the government and a private company for the management of water led to a revocation of the contract between the two (Colombo 2020). The work of NGOs and citizens in tandem with the government led to the creation of a new article in the Bolivian Constitution to protect water, and later on to a UN resolution on the human right to water. This example shows how although national governments tend to have higher resource capacities, lower administrative levels can levy change that positively affects citizens across the country.

Since remunicipalisation requires the consideration of several factors including the maintenance of water quality, guarantee of a secure water supply and sewage disposal system, and minimization of costs, full remunicipalisation of water management is an uncommon achievement. However, efforts to implement local regulations to control the prices and distribution of water have been successful in ensuring equitable access to water in some cities across the world.

C. Expert Knowledge

As experts from the water sector interviewed emphasised, water is a very technical topic, so the need for experts in the sector is a pressing requirement. This is particularly true for mid-sized cities that do not usually have the same amount of expertise as larger cities like Paris (Barles 2009).

These types of resources can be implemented in different ways at the level of municipalities. First, to provide more expertise at the local level, municipalities could create new departments in the fields that lack expertise, as policymakers interviewed have stressed the importance of making water a more political subject because of its crucial importance in the fight against climate change. However, the lack of financial incentives of smaller cities and the economic attractiveness of larger ones can be a limiting factor. Another perhaps complementary solution involves the implementation of pedagogical efforts in French municipalities. This can take the form of public awareness campaigns, webinars, and workshops. An example of this is the Académie du Climat in Paris, which often hosts public events focusing on climate change and environmental sustainability (Ville de Paris 2021). Smaller cities, which may struggle to host in-person expert seminars, can offer digital webinars and workshops to promote awareness of climate issues. Further, municipalities can host seminars for local government employees and relevant stakeholders to mainstream climate knowledge and policies. As participation in digital workshops is dependent on the time that participants can dedicate towards the event (Ekstrom et al. 2020), workshops which include pre-recorded material and engagement during a specific window of time can serve as a solution. This way, participants who may lack availability can benefit from the flexible timing of the event.

MANAGERIAL CAPACITY

As described in the previous chapter, the managerial capacity of French cities is primarily limited by institutional fragmentation. Climate change guidelines from the national scale can be ambiguous and leave room for interpretation (Therville et al. 2018). While studies demonstrate the need for coordinated multilateral climate governance, the bureaucratic complexity of French climate governance has hindered the managerial capacity of mid-sized cities. In the context of water management, this has resulted in frustration at the local scale regarding the management of potentially scarce water resources in years to come. Since water resources are not geographically constrained to administrative boundaries, the governance of transboundary climate risks is therefore a critical topic for local governments.

Climate change risks such as water scarcity, heat waves, and flooding, will transcend legal jurisdictions. In the same sense, strategies to respond to climate change can have impacts beyond borders (Benzie and Harris 2020). Though studies on the governance of transboundary climate risks are still premature, they suggest that climate risks require multilateral coordination and collaboration (Moser and Ekstrom 2010). The adaptation strategy of the EU, for example, has integrated this framework by boosting international engagement such as the support of climate resilience projects in developing countries (European Commission 2021). Local governments can manage transboundary climate risks through several mechanisms, including the installation of local climate resilience officers, the creation of climate strategies with co-benefits, the implementation of monitoring and evaluation systems, and the use of information and communication technologies (ICTs).

A. The Implementation of Local Climate Resilience Officers

As coordination issues often stem from a lack of communication between different stakeholders, one solution to this problem is the installation of chief resilience officers (CROs) in municipalities. This position, inspired by the Rockefeller Foundation's 100 Resilient Cities initiative, would have the role of coordinating the local response to climate change. As the local response to climate change and the management of water resources suffers from fragmentation, CROs would be responsible for coordinating policies and strategies across different administrative scales to design a comprehensive local approach for addressing climate change and water use.

Locally appointed climate leaders have been shown to enhance local managerial capacity in cities around the world. South Africa's Thekwini municipality, often regarded as a global leader in anticipatory climate resilience, cites the existence of a local climate resilience team as a key factor in its successful adaptation response (Roberts 2010). Michael Berkowitz, the President of 100 Resilient Cities, explains that "Cities don't all have the same needs" and "local resilience officers can help the mayor take a new approach" (Berkowitz and Matus Kramer 2018). One barrier to the appointment of local climate officials is lack of funding (Pasquini et al. 2014). This could be tackled with the allocation of European and French climate change budgets to fund the position. But, as foundations like the 100 Resilient Cities are funded by private actors, it is more realistic for the state to incentivize and attract private funding.

B. Adaptation Measures with Co-Benefits

One strategy to managing transboundary climate risks is to design adaptation strategies with co-benefits. Participatory planning processes, which involve the collaboration of multiple stakeholders from the public and private spheres, can produce local climate plans that have co-benefits across multiple sectors (Berke and Lyles 2013). Many carbon emission reduction strategies in cities produce co-benefits for human health. The creation of bicycle lanes in cities, for example, can promote cardiovascular health and reduce the amount of particulate matter in the air (Jarjour et al. 2013). In the context of water, the creation of urban green spaces can reduce stormwater runoff and water pollution (Manning 2008). The coordination of climate strategies at the agglomeration and EPCI level, particularly regarding transboundary water resources, can promote facilitation and cooperation among actors.

Case Study Box: Infrastructure with Co-Benefits in Copenhagen

In response to local floods, the Copenhagen City Council decided to implement blue-green infrastructure projects throughout the municipality. Blue-green infrastructure is a method of managing stormwater while simultaneously increasing green space. In Copenhagen's Tåsinge square, a public space surrounded by brick buildings which were vulnerable to flooding, asphalt was replaced with a green garden, benches, and stones. Since green spaces can also promote health and social cohesion, the transformation of the square enhanced stormwater drainage while enhancing the wellbeing of local residents at the same time.

C. Monitoring and Evaluation Systems

While French municipalities and agglomerations are increasingly creating climate resilience plans, their effective implementation relies on monitoring and evaluation strategies. These follow-up processes are challenging for local governments, as they rely on the coordination of local stakeholders to monitor impacts across different sectors (Alibašić 2018; Scott and Moloney 2021). Thus, each local climate plan would require the identification of parties responsible for monitoring progress, a selection of indicators for measuring success, identification of obstacles to implementation, and provisions for public involvement in the monitoring process (Berke and Lyles 2013). Evaluation of a climate plan would be conducted at the end of a designated time frame. For example, a climate plan could be evaluated after two years and would be followed by the creation of an update plan based on the findings. The monitoring and evaluation of climate plans are essential elements of adaptation planning and inform French policymakers of the effectiveness of certain initiatives.

D. Digital Governance Tools

Information and communication technologies (ICTs) have demonstrated potential for enhancing urban sustainability and facilitating governance efforts. Digitalization, according to George et al. (2019), is highly scalable and can address different managerial issues. The use of digital tools in urban sustainability initiatives can improve communication, increase the accessibility to information, enhance coordination among stakeholders, and promote governmental transparency (Balogun et al. 2020). By creating a centralised digital platform in which stakeholders can communicate about climate change strategies and share progress updates, municipalities can better manage the actions of key actors. An example of this is a website created by a Norwegian municipality. In this case study by Ibrahim (2022), a private company was hired to create a website which features progress shares, strategies to be achieved in their local climate plan, and the management design of each strategy. The benefits of having this website include the ability to clearly define local challenges, assign tasks to different actors, and monitor the success of each strategy. Another way in which cities can use digital tools to increase managerial capacity is through the use of smart water metering (SWM) technology. SWM technology enables urban water managers to analyse consumption patterns and detect water losses (Randall and Koech 2019). By implementing SWM technology, cities can gain insights into the water metabolism and design measures to reduce water consumption.

LEARNING CAPACITY

Learning capacity refers to the ability of a municipality to adapt to uncertainty. As the physical and socioeconomic impacts of climate change are highly variable, it is critical that municipalities have a high capacity to cope with uncertainty (Collins and Ison 2009; Mees and Driessen 2011). In France, learning capacity is limited by lack of vertical communication structures between both higher administration levels and the local populace. Ways to enhance the learning capacities of municipalities include climate policy experimentation, digital storytelling, and exchanges of information with cities around the world.

A. Policy Experimentation

Local policy experimentation is a growing topic in the field of climate governance (Matschoss and Heiskanen 2017). As climate change requires flexible policies that can be easily amenable as climate projections shift, experimentation enables cities to test novel policies and get valuable insight on them. The conditions in which policy experimentation can occur involve trust between relevant stakeholders and the financial capacity to test potentially risky strategies. Mid-sized French cities can engage in policy experimentation with the help of intermediaries who can provide financial and material means that would otherwise be inaccessible. In France, these intermediaries include water agencies, city networks, and national government. They also include private stakeholders, as often public intermediaries lack financial resources to develop their programmes. Kivimaa (2014) explains how experimentation in reducing carbon emissions can challenge existing political institutions and business-as-usual practices. In the context of water, Bos and Brown (2012) found that opportunities for experimentation in urban water governance include local workshops, collaborative planning and vision-setting, community tours of water facilities, surveys on local knowledge, and online newsletters updating citizens about water governance strategies. These programs are often already in place but not visible enough (due to faulty communication or lack of commitment from the interested parties). These projects can enable elected officials to enhance communication with local citizens and should therefore become a higher priority in the political agenda of municipal officials.

B. Digital Engagement Tools

Digital tools are increasingly used to involve citizens in climate change issues. Knowledge-sharing platforms, digital games, and participatory maps are all examples for strategies used by cities to engage local citizens with climate change issues. Digital storytelling is another strategy for connecting government leaders with local citizens. It has facilitated the ways in which citizens can connect with local government leaders. Digital storytelling is the act of sharing personal narratives on digital platforms. Studies have shown that digital storytelling can help co-produce knowledge needed for local governance, particularly emphasising the voices of marginalised groups (Adelle, Black, and Kroll 2022).

Storytelling initiatives include the creation of online platforms for citizens to reflect on local policy initiatives or collaborative maps in which citizens can place points on a map to suggest initiatives or give feedback on existing strategies. An example of collaborative mapping was led by the North Country Food Justice Working Group (2018). This digital map, titled 'Food Justice in the North Country', was the outcome of a regional food justice conference at which participants could place notes on a physical map detailing places in which they hope to see changes. The digitalization of the map allows the map to be shared across greater geographical distances and can provide policy makers with insights into local needs.

C. Knowledge Sharing with Different Cities

As briefly mentioned in the Resource Capacity section, city networks hold vast potential for sharing climate change governance. Cities choose to join networks for a variety of reasons, including opportunities for funding and enhanced learning capacity. This section will focus on the latter. City networks such as C40 and the Fédération Nationales des Collectivités Concédantes et Régies (FNCCR) enable cities to access platforms and knowledge resources. After committing to a set of sustainability standards, cities are able to turn to other cities to understand effective policy implementation strategies. As described by Meijers et al. (2015), small and medium-sized cities can compensate for their smaller access to resources by joining networks, as these organisations strengthen various governance capacities. While the climate challenges and legal frameworks of cities vary, networking with cities with similar challenges and population sizes can provide municipal government leaders with an array of tools for implementing effective adaptation strategies. This includes strategies for the management of urban water resources.

Case Study: Rotterdam's Hackathon for Climate Adaptation Education

In the Netherlands, flood risks are managed exclusively by regional authorities and involve minimal citizen input. Responsibilities for flood adaptation measures, however, are designated to the municipal governments and their citizens. For this reason, various municipalities have been experimenting with digital learning tools to increase citizen engagement in adaptation planning. In 2020, Rotterdam hosted a Digital Education Hackathon to invite the public to propose digital solutions for increasing citizen involvement. The challenge invited participants to create a game for students to engage with the local impacts of climate change. The winner of the Hackathon was a group of students from The Hague who created a simulation in which the player encounters climate challenges and must resolve them using strategies from an adaptation tool kit.

POLITICAL CAPACITY

A. Leadership: the Key Role of Citizens and Mayors

Alongside legal capacity, political capacity is considered to be among the strongest capacities at a city's disposal following the framework by Mees and Driessen (2011). The first aspect of political capacity this report touches upon is that of leadership. On one hand, citizens play an important role in the establishment of leadership (ex., election of mayors) and by keeping this leadership alive through political support. The stronger the leadership, the more political support from citizens. On the other hand, the more political support, the stronger the leadership. But how, in practice, does leadership become stronger?

One solution is to put the ecological transition at the forefront of political campaigns. Through public awareness campaigns about specific water issues that affect municipalities, citizens are made aware of issues of which they might have not been well informed otherwise. For example, in the case of Arles, this could occur by mobilising agricultural associations by giving them a stage to express their needs and their experiences of water scarcity related problems. Informational campaigns can also increase climate-friendly behavior of citizens. In her article on waste management, Kirakozian (2016) shows that campaigns inducing a 'pro-environmental attitude' are positively correlated with selective sorting and other climate-conscious behaviors. If employed strategically by political leaders, these actions can enhance citizen willingness to participate in the political life of mid-sized cities and thus favour the credibility of leaders.

Finally and as was mentioned previously, local elected officials can join networks of mayors. An example is the Global Covenant of Mayors for Climate and Energy, which welcomes cities of all sizes, unlike C40 or 100 Resilient Cities that are more selective. It is a European Commission initiative, whose aim is "to increase support for local activities, provide a platform for greater engagement and networking by cities, and raise public awareness about adaptation and mitigation and the measures needed" (Climate Adapt 2022). A similar network could be followed by mayors of mid-sized cities in France who are facing water-stress related challenges (Heyvaert 2013).

B. Political Will: Multi-level Governance Visions

The second aspect identified within the framework of political capacity is political will, which is necessary to implement adaptation policies and integrate them effectively in political agendas. However, as discussed in Chapter 2, there is sometimes a disconnection between the national scale and and what municipalities are able to implement at the local level.

Firstly, with the political influence of the national scale, municipalities can more easily implement guidelines. An example of this is the creation and implementation of local climate action plans. In the case of Saint-Nazaire, Bourg-en-Bresse and Arles, local climate action plans do not often take into account water issues because they can be broad and complex. The national government, in response, can work to coordinate the intermediate actors (e.g., water agencies) which can help the translation of climate plans into more efficient and smoother actions. This type of coordination between different levels of governance can be referred to as multi-level governance (Bache et al. 2016).

However, to make a multi-level governance model work, the sole creation of EPCIs is not enough. A long-term environmental vision is required to tackle the pressing threats of climate change. A perspective on the future of water and its governance that takes into account multiple stakeholders and competences among the various levels of governance is necessary. What provides the political will to turn these visions into local climate action plans is the holistic picture that the national state only can possess over the realm of water and which must be reinforced to meet guidelines and benchmarks.

C. Accountability: Meeting targets

French governmental bodies need more open and transparent processes from the main actors involved in the ecological transition, more active engagement from stakeholders and the public, and more honest dialogue about the challenges of meeting environmental targets. The latter is particularly relevant, as many interviewees reluctantly admitted to their failure as municipalities in meeting targets set at the national or European level for water. This failure was also a result of the impossibility to be held totally accountable for complex problems not easily manageable on their own (ex. water pollution). Guidelines on ecological targets are sometimes, if not often, perceived as sanctions coming from above. From the national to the local scale, this can appear as a top-down approach. As a result, municipalities may struggle to meet even the easiest targets. Some targets, such as pollution, may also be difficult to meet because their management spans across various administrative boundaries.

One solution is for the national government to accompany municipalities in the process of meeting these targets, for example, by deploying more water experts to mid-sized cities to assist in the implementation of projects. Another solution is to frame targets and regulations differently. Research shows that the role of marketing the effects of environmental charges can shape public opinion about the charges as explained in the case study below (Eliasson and Jonsson 2011).

If French national and regional regulations market environmental targets in a way that better highlights the benefits of adhering to certain environmental targets, it might help mid-sized cities to be more prone to implementation of local actions on water issues. Most importantly, public authorities should aim at reaching these targets by promoting fair goals, as environmental reforms sometimes overlook the needs of the most marginalized.

Case Study Box: The Marketing of Stockholm's Congestion Charge

Studies show that familiarity with congestion charging schemes can increase their public acceptance (Eliasson and Jonsson 2011). An example of this is Stockholm's congestion charge. Initially, the congestion charge was phrased in financial terms (David and Olsson 2017). Citizens subsequently understood the charge as a cost rather than a benefit. Thanks to a successful political communication and public awareness campaigns, the public opinion shifted after the municipality of Stockholm started to frame the congestion charge as an "environmental charge." This marketing strategy allowed citizens to understand the environmental benefits of paying for accessing the city by car: reduction of air pollution and traffic for the sake of a greener and healthier city. While marketing played a role in the public acceptance of Stockholm's charge, it is important not to simplify the discourse. What is most relevant is how this charge, in practice, relates to questions of social justice. Is it affordable for all socio-economic groups? If not, who are the most vulnerable? How can policies address their needs?

PART 2

As the impacts of climate change will overwhelmingly be felt in urban areas, urban climate policies are highly relevant for the well-being of both urban and planetary health. Navigating urban climate policies through the lens of urban metabolism enables city officials to view sustainability issues as part of an interconnected system. Identifying material flows with high consumption patterns, for example, can illustrate to officials where they should focus their policies. This is particularly relevant for the case of water. For example, a study by Flörke et al. (2018) demonstrated how competition for water between cities and agricultural areas is exacerbated by climate change. Using an urban metabolism approach to map urban water sources, the authors found that increasing urban water demands, coupled with hydrological impacts of climate change, will lead to urban water scarcity in many cities around the world. In another study, Barles (2009) analysed the urban metabolism of Paris and discovered deficiencies in urban waste policies. By analysing the different material flows of Paris, Barles revealed very low recycling rates and a heavy dependence on construction imports. Such studies illustrate how adopting a metabolism framework for urban sustainability issues can have significant policy implications.

Water management documents such as the SDAGE and SAGE described in Chapter 1 encompass transboundary water resources. Yet, while the SAGEs focus more on municipalities, SDAGEs focus on the basin level, more apt for delineating water basins boundaries, rather than using administrative borders. Many interviewees, particularly from the CARENE in Saint-Nazaire, highlighted how to analyse water flows, a larger territory needs to be taken into account. The SDAGEs schemas, then, employ a metabolic approach to address the flows and quantities concerning the basin level. The first and main objective of the SDAGEs is to "restore good ecological quality of water and ensure its renewable character in the environment and affordable for the citizen" (Les Agences de l'Eau 2022). The term 'renewable', for example, under the lenses of urban metabolism, could be understood as indicating the continuous input and output flows of water within the urban water metabolic cycle. Another priority is to "(re)build a coherent ecological network that allows species to circulate and interact, and ecosystems to continue to render their services to humans" (Les Agences de l'Eau 2022). That is, again, to favour the circulation of water flows, but also of what comes within these water flows: interdependent species of the water ecosystem.

Although the concept of urban metabolism has not been implemented in many cities, growing literature is showing the benefits of using this framework. Interviewees were not particularly knowledgeable on the topic. However, seeing as many of them highlighted the need for a systemic approach to climate issues, urban metabolism could offer this overview of their territory and help officials understand anticipate water and other climate-related challenges.

Discussion and Conclusion

Based on academic literature and interviews with more than 20 actors in the water governance sector, this report has laid out the physical impacts of climate change that have manifested and will continue to manifest in various ways across France. The management of water was chosen as a focus to illustrate the larger climate-related challenges faced by mid-sized cities in France. Water is one of the most important yet threatened resources and it is at the heart of climate change. In coastal regions, as demonstrated in the case study of Saint-Nazaire, impacts of climate change include flooding and sea level rise. Piedmont regions, where Bourg-en-Bresse is located, are particularly vulnerable to heat waves and drought. Riverine regions, such as Arles, are subject to both flooding and agricultural losses due to intensified heat waves.

French climate change and water policy is shaped by international, national, regional, and local policies. At the international scale, French policy is shaped by entities such as the United Nations and European Union. As the impacts of climate change continue to threaten water resources throughout the country, robust climate change policies are ever more crucial. However, although France is subject to international directives such as the Water Framework Directive, the country is failing to meet the targets for clean water and adaptation to floodings. These threats were deemed crucial for urban areas by reports from the IPCC and the OECD, so they need to be addressed quickly to avoid irreversible damage.

This research project analysed the current policies of water management based on the basin level. Using the governance capacity framework developed by Mees and Driessen (2011), the authors of this report examined the potential governance challenges for the five categories of governance capacity: legal, managerial, resource, political and learning capacities. For each capacity, the issues observed were reported and solutions were proposed.

Water management in mid-sized cities is restricted by the legal competences they possess. Methods to increase their legal capacity primarily lie in the collaboration with neighbouring municipalities. The competence of GEMAPI, for example, was recently bestowed upon intermunicipalities. Thus, municipal governments are able to benefit from legal capacity to govern local flood risks through their membership to EPCIs.

One of the main limitations to governing the ecological transition in the water sector is lack of resources. This includes economic, knowledge, and human resources. Solutions for increasing financial capacities in mid-sized cities include utilising budgets of EPCIs for implementing adaptation measures or engaging in public-private partnerships (that should still remain highly regulated). To increase knowledge capacity, cities can create municipal climate change departments.

The learning capacity of public powers is the continuous learning process of exchanging information and dealing with uncertainty, which is at the core of climate change. In French mid-sized cities, learning capacity is limited by a lack of stakeholder dialogue and knowledge exchange. Methods for increasing learning capacity include policy experimentation, digital storytelling, and knowledge sharing with city networks.

Managerial capacity refers to the ability of local governments to coordinate with other actors to achieve common goals. Coordination between entities of water management and governance is still fairly limited in French cities, which suffer from institutional fragmentation. Solutions to increasing managerial capacity of mid-sized cities include appointing local climate resilience officers, implementing adaptation measures with co-benefits, strengthening monitoring and evaluation systems, and utilising digital governance tools.

Political capacity encompasses the accountability of public authorities, their political will to implement transformative environmental actions, and leadership in multi-level governance. Challenges to this capacity in French municipalities include a lack of political vision centred on climate change adaptation and a lack of vertical support from higher levels of government. For this reason, one solution for increasing the political capacity of mid-sized cities is to join networks of mayors. Joining such networks enables cities to gain legitimacy in resilience efforts and be held accountable for their actions through norm-setting.

Finally, an innovative and underused solution proposed in this report is the analysis of flows. Urban metabolism is an interdisciplinary approach to studying the sustainability of cities, which focuses on resource flows in and out of cities. Navigating urban climate policies through the lens of urban metabolism enables city officials to view sustainability issues as part of an interconnected system, which was stressed by many experts as a crucial aspect of climate related policies that is lacking in water governance in France.

This report has highlighted governance challenges experienced by mid-sized cities and has proposed a tool for elected officials to follow to try to improve their management of water, a key resource that is threatened by climate change. With more time at their disposal, the researchers could have interviewed a higher number of influential elected officials in the field of water governance. This report included input from various actors in the field of water, but lacked perspectives from more elected officials.

It is important to note that many countries in Europe are experiencing similar issues with reaching the EU-mandated targets, and that France remains one of the pioneers of water governance. Yet, mid-sized cities struggle to enhance their governance capacities which hinders their abilities to adapt to climate change. Future work on the topic could analyze in more detail the specific targets, national and international, that are not being met by cities. This could include asking how mid-sized cities with limited resources can actually reach strict targets and track their progress. As was noted in this report, the monitoring and measuring of the progress of cities in reaching targets is a crucial aspect of meeting these targets.

Urban metabolism has been identified as an important solution to get a systemic understanding of resources and the reliance of cities on different resources that are becoming scarce. This report does not delve into the technical analysis of water flows in cities, but rather on its theoretical benefits for experts in water governance. Water governance is a very complex and technical subject, so the study of its urban metabolism will benefit from future studies on the technical aspects of data collection and dissemination. Although the field is still in its infancy, the benefits of this type of analysis are becoming increasingly clear to academics. Scholars should expand on the ways in which elected officials can obtain the data needed to map out those flows and utilise the information to strengthen their capacities to govern the ecological transition.

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