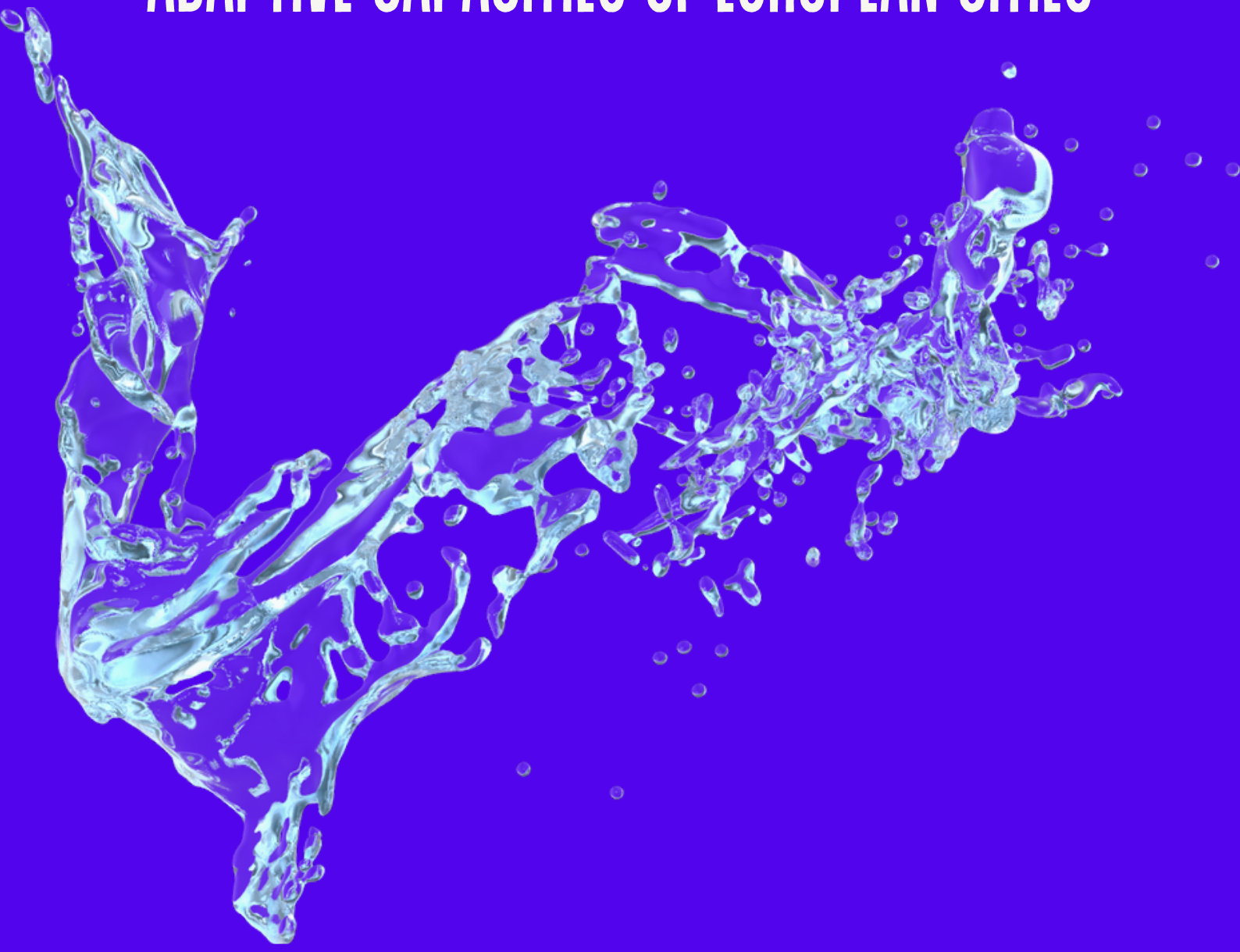
SOAK IT IN!

ADAPTIVE CAPACITIES OF EUROPEAN CITIES



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I. EXECUTIVE SUMMARY

This report addresses policymakers on urban water management on all governance levels, city networks and stakeholders working with cities to adapt to water-related challenges.

Urban water management across Europe faces increasing pressures from climate change, evident in severe flooding and prolonged drought conditions. Traditional infrastructure, originally designed for stable weather patterns, no longer meets these emerging challenges. Cities require adaptive and integrated water management solutions to enhance resilience, ensure sustainability, and improve the quality of urban life.

This report examines the governance dynamics shaping urban water resilience through detailed analysis of three European cities and one region: Berlin, Bologna, Bordeaux, and Lower Austria. The analysis is based on five comparative criteria:

1. Governance, coordination, and leadership
2. Public engagement and awareness
3. Data, knowledge, and evidence-based action
4. Policy integration and strategic planning
5. Resources, triggers, and incentives

The findings reveal the different methods and challenges in governance dynamics to shift toward comprehensive urban water strategies, such as Water Sensitive Cities (WSC). For example, in Bordeaux a central GEMAPI authority coordinates flood management across municipalities. In Bologna multiple agencies at various administrative levels collaborate to tackle water challenges. Berlin's Rainwater Agency engages citizens and building owners through educational initiatives and interactive tools. Lower Austria boosts community preparedness by supplying detailed flood hazard maps. Leveraging these and supplementary insights from our research, the report proposes six tailored recommendations for policymakerss:

1. Support pioneers across sectors and encourage proactive municipal leadership to unite stakeholders.
2. Adopt context-sensitive strategies that prioritise cross-boundary data sharing and collection to address location-specific challenges and opportunities effectively.
3. Incentivise collaboration beyond administrative borders to create campaigns, interventions, or regulations focused on rivers as geographical entities.
4. Promote inclusive decision-making and transparent communication within and outside public administrations to cultivate community involvement and public awareness.
5. Combine large-scale interventions and infrastructure projects with water-sensitive solutions, utilising the momentum.
6. Create a Knowledge Hub to disseminate best practices across Europe.

Policymakers are invited to use these recommendations to strengthen holistic approaches to urban water resilience, becoming increasingly urgent in times of climate change.

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1. BREAKING THE SURFACE

1.a Introduction to the Topic

Water management has recently become an urgent topic in urban areas across Europe. In the context of rapid climate change, increasing flooding, caused by extreme rainfalls, and water scarcity from droughts, traditional grey urban infrastructures are put under pressure. As European cities continue to grow and densify, current infrastructures which were designed for predictable hydrological patterns are increasingly proving insufficient[1]. In this prospect, cities must embrace a wider range of solutions, such as blue and green infrastructures*. Such strategies not only mitigate risks but also provide benefits such as improved urban biodiversity, enhanced public spaces, and social equity[2]. Cities therefore, have started to experiment with developing more adaptive, integrated and socially inclusive urban water management strategies. The most renowned ones are Copenhagen's Cloudburst Plan or Amsterdam's Rainproof strategy.

However, the implementation of green and blue infrastructure across the EU remains uneven and fragmented[3]. Extreme weather events showcase regularly that European regions and cities are not yet fully adapted to the emerging challenges stemming from climate change. Being able to understand the governance dynamics behind urban water resilience is therefore essential to identifying transferable lessons and developing broader transformations. This policy report, **aims to provide insights into how different European cities, all united by growing water related challenges, aim to adapt to the increasing risks related to urban flooding and extreme weather events**.

After a review of the current status quo related to EU policy and the academic discourse on the governance of climate change adaptation in urban centers, the report will look into four city cases to elaborate the cities' respective actions and structures to adapt. In that prospect, we aim at providing a study that focuses on four European cases: Berlin, Bologna, Bordeaux, and Lower Austria. We are going to explore how urban and regional actors govern rainwater in response to climate extremes. Through a comparative approach, we examine how different institutional frameworks, governance cultures, and actor configurations enable or constrain the transition toward more resilient, adaptive rainwater management systems. Based on the findings, the report will propose several policy recommendations to policy-makers across different levels of governance to be taken into consideration when thinking about implementing water sensitive regulation and interventions.

*In contrary to grey infrastructure (traditional, engineered systems such as sewer networks, pumping stations, water treatment plants, levees, and other hard infrastructure), blue infrastructure refers to natural or human-made water-related elements like rivers, lakes, canals, wetlands to respond to ecological, social, or economic challenges in land use and urban planning, and green infrastructure refers to natural areas improving ecosystem services (cooling urban areas, supporting biodiversity, and offering recreational spaces) and improving quality of life.

1.b Urban & Climate Change

According to the European Environmental Agency (EEA), Europe is the fastest-warming continent in the world. Extreme heat, once relatively rare, is becoming more frequent while precipitation patterns are changing. Downpours and other precipitation extremes are increasing in severity, and recent years have seen major floods in various regions, such as in the Ahrtal, Germany or Valencia, Spain[4].

In general, it is expected that extreme weather events such as heat waves, heavy precipitation, river floods, windstorms, landslides, droughts, forest fires, avalanches, hail and storm surges, and slow-onset events (e.g. coastal erosion, prolonged wet periods, prolonged dry periods, biological colonisation) will increase in the coming decades across Europe, based on projected changes in climate[5] [6].
The most recent European State of the Climate report (ESOTC) highlights that extreme weather due to climate change has devastating impacts all across Europe. Of the approximately 18.2 billon € of damages caused by extreme weather, 85% can be attributed to floods in 2024. 12% of the whole river network in Europe surpassed the severe and 30% the heavy flood threshold in 2024, costing the lives of at least 335 people. The Intergovernmental Panel on Climate Change has found Europe to be one of the regions with the largest projected increase in flood risk[7].

At the same time, the EU is one of the most urbanised areas in the world (out of 447 million EU inhabitants, 75% live in urban areas, reaching up to 80% until 2050). European cities' old infrastructures and path-dependent water management systems make them particularly vulnerable to increased likelihood and frequency of extreme weather events[8]. Therefore, extreme weather events can have devastating consequences on people's lives, specific economic sectors and nature[9]. Technologies and governance systems are often "ill-equipped to handle rising demand, environmental challenges, continued urbanisation, climate variability and water disasters"[10].

In this context, pressure is on policy makers to find ways in which countries, regions, and cities at all levels, have the right tools to adapt their infrastructures to the future scenarios, whilst mitigating the root causes of climate change. An emerging discussion across Europe is the use of sponge city interventions, that use green and blue infrastructures and nature based solutions to tackle the above mentioned issues, whilst also mitigating some of the major contributors to increasing climate change.

1.c Sponge City & Water Sensitive City - Two Emerging Concepts

The "Sponge City" concept emerged from China as an innovative approach to urban water management, emphasizing the mimicry of natural hydrological processes to mitigate flooding and enhance water resilience[11] [12]. Strategies of the approach include water infiltration, detention, storage, treatment, and drainage to address stormwater challenges. Sponge Cities aim to improve urban climates, reduce heat loads, manage water locally for irrigation or recharge, and protect local water bodies[13].

As a comprehensive solution, Sponge Cities gained political and public traction for their ability to address urban water issues while enhancing urban greening and livability. Despite its strengths, the Sponge City concept has notable limitations. The Sponge City concept focuses on stormwater management and urban resilience, with its effectiveness and applicability dependent on local conditions and implementation[14]. Because of varying topographic and climatic conditions the sponge city approach needs to be tailored to cities individually, making the resulting interventions hard to compare. The lack of integrative planning approaches within the sponge city concept can further hinder integration and effectiveness. The critique, that oftentimes Sponge City refers to small scale lighthouse projects on the neighbourhood level was confirmed by our initial research. By calling the project “Sponge City” it is easily conveyed that the project is based on a city scale and therefore integrated, which is often not the case.

The use of the term Sponge City to label projects can not only be confusing but also blurry, since the concepts of Sponge City, Water Sensitive Design, Blue Infrastructure and Sustainable Urban Drainage Systems (SUDS) and related approaches like Integrated Urban Water Management (IUWM) and Green Infrastructure (GI) often overlap. This happens, as they share a core philosophy of using natural processes to manage water, but their interchangeable use highlights the lack of clear, consistent definitions across contexts[15].

A "Water Sensitive City" (WSC) represents an evolution of water management thinking, offering a more holistic, multi-level approach. Defined by its circular management of water resources across neighborhoods, cities, and regions, a WSC integrates water management with other urban sectors such as climate adaptation, land use, and economic development[16]. It addresses interconnected water systems, transcending administrative boundaries and requiring inclusive governance to navigate multi-stakeholder challenges[17].

By integrating water-sensitive design with urban planning, WSCs can enhance resilience and sustainability beyond water challenges, yielding co-benefits like cost savings and improved urban livability[18]. Existing platforms and projects, such as Covenant of Mayors, the Urban Water Atlas for Europe, Climate-ADAPT, OPPLA, UIA, Horizon 2020, and LIFE have explored water sensitive city planning and serve as dispersed knowledge hubs for pilot solutions[19]. Yet, the Water Sensitive City concept is not without challenges either, as there remains a critical need to consolidate scattered knowledge and provide clear guidance on defining and implementing the concept effectively across diverse local contexts[20].

The "Water Sensitive City" framework surpasses the "Sponge City" model by addressing its limitations and providing a more comprehensive vision for sustainable water management. While Sponge Cities focus predominantly on smaller scale projects dealing with stormwater, the WSC-concept incorporates a broader range of water challenges, and especially focuses integration across various sectors. By promoting inclusivity and adaptability, WSC aligns better with global sustainability goals and diverse local needs, making the term more suitable for driving transformative change in water management practices.

1.d EU Policy and Literature Review

The European Union's water policy rests on Articles 191–193 of the Treaty on the Functioning of the European Union, giving competence to the EU to manage water as both a common good and a vital resource .[21] [22] [23] Since the first adoption of the Drinking Water Directive in 1980, successive legal instruments have built a comprehensive framework for safeguarding water quantity and quality, coordinating transboundary cooperation, and addressing climate-induced extremes[24].

At its core sits the Water Framework Directive (2000/60/EC), which mandates EU member states to organize water management based on natural river basins, assess ecological and chemical statuses, and deliver River Basin Management Plans every six years. In parallel, the Floods Directive (2007/60/EC) requires a three-step cycle: risk assessment, mapping, and management planning[25]. This allows the development of appropriate interventions that focus on prevention (restoring floodplains, wetlands and natural buffers), protection (engineering solutions like levees where necessary) and preparedness (early-warning systems and emergency response). Together, these directives integrate flood mitigation into broader water stewardship, ensuring that measures to improve water bodies, such as the restoration of the watercourse ecosystem simultaneously reduce flood risk linking water management to the nature restoration regulations of the EU[26].

As stated in the previous section, addressing water scarcity and drought has become an increasingly critical challenge in the EU. Member States are thus required to integrate drought-management measures into their River Basin Management Plans. These include demand-management programs, leakage reduction, water reuse targets, and dedicated drought-management planning, designed to secure water supply during prolonged drought periods[27].

In line with climate change mitigation goals and effective in tackling both floods and droughts, the European Commission emphasizes nature-based solutions (NBS) as sustainable strategies[28]. NBS move away from technology and concrete-intensive water management solutions and towards green-blue infrastructure. Prominent examples include restoring wetlands and re-meandering rivers to slow runoff and recharge aquifers (e.g. through the LIFE CONNECTS project in Sweden); creating green urban corridors, urban forests, and bioswales to intercept stormwater, reduce heat-island effects, and sustain base flows. It also includes installing permeable pavements, green roofs, and rain gardens to capture and infiltrate rainfall at source.

To help cities and urban actors deploy these NBS, the EU provides targeted funding via NextGenerationEU, the Cohesion Fund, the European Regional Development Fund (ERDF), LIFE Programme grants, Horizon Europe innovation funding, Urban Innovation Actions, URBACT networks, European Investment Bank green loans, and the Just Transition Fund.

Furthermore, when it comes to water, the EU is explicitly also supporting the urban level. Here the Urban Water Agenda 2030 seeks to galvanize municipal political commitment and voluntary action to bolster sustainable urban water management across the EU.

In the context of the above described water challenges in the urban context and the EU's regulatory framework, the Urban Agenda for the EU (UAEU) created by the pact of Amsterdam, will launch, based on the Gijón Agreement (2023), a thematic partnership to explore the topic of water sensitive cities[29].

Much of the work of the thematic partnership will be informed by the ex-ante assessment of the "Water Sensitive City" thematic area under the UAEU. It was conducted to offer a fundamental overview on the current gaps in knowledge of the UAEU, practices, and policies both at EU and Member States levels[30]. A key finding was that a comprehensive European framework for Water Sensitive Cities is currently missing. It also emerged that several sector specific policies such as the Common Implementation Strategy (CIS) for the Water Framework Directive, the Code of Conduct on Partnership for managing the Cohesion Funds or the Cohesion for Transitions (C4T) Community of Practice exist to provide sector-specific guidance.

The assessment highlights that knowledge in this field exists and is indeed well-grounded, but it is currently spread out and not easily accessible to small- and medium-sized cities, which present knowledge and funding gaps. Hence, in the emerging partnership that will be guided by the ex-ante report, city stakeholders across Europe will draft action plans to become more adapted to emerging water-related challenges with concrete recommendations and liaise with the EU institutions to embed those actions in policy, funding and implementation guidelines to scale across cities.

On top of that, the Urban Water Atlas for Europe is a tool that has proven useful in understanding the most relevant issues related to water that a selected number of cities across Europe are currently facing. By providing a snapshot into each city's relationship with water, the Atlas offers a bird's eye view on where priorities currently lie in each of the numerous cities represented, as well as a series of lighthouse projects. Through this it is possible to understand that there is not one single approach that can be applicable to all cities, given their overwhelming diversity in terms of history, governance structures, and water related issues.

When taking a look at existing academic literature on the topic of governance of water management approaches, authors, such as Burch, show how the institutionalisation of climate change response measures will become increasingly critical in addressing issues such as urban floods and prolonged droughts. Several critical enablers for action are identified here, such as the necessity for strong leadership -both political and administrative- an efficient use and leverage of existing resources of financial, technical, and human nature, and an adaptive leadership approach[31].

Furthermore, elements such as stakeholder involvement and community participation are found to be of great importance in the implementation and streamlining of climate adaptive policies. What emerges is that those strategies that focus solely on interventions on individual pieces of infrastructure while neglecting overarching themes such as social or institutional elements, are less effective than more holistic measures. A comprehensive and integrated approach to extreme weather event adaptation needs to incorporate institutional, social, and physical measures alike. A lack of clear mandate to local municipalities and misalignment between local and national policies has also been found as an obstacle to efficient policy implementation[32].

Fournier et al. provide a series of criteria of adaptive governance that have proven useful in better understanding the four case studies at hand as well as drafting a comparative framework[33].

For example, the City Water Resilience Framework emphasises that institutional designs must reflect adaptive capacities, resource availability, and leadership readiness, suggesting that resilience emerges not merely from infrastructural investments but from the very architecture of governance itself[34]. Therefore, analysing the multilevel governance processes, understood as a balance between top-down and bottom-up decision making, is central to understanding the working and policy mainstreaming in each city.

Criteria such as the existence of multi-actor networks and level of citizen participation can help identify challenges and limitations in risk perception and stakeholder coordination. The literature also highlights how despite an overall increase in public participation and steps towards more integrated approaches being taken across Europe, these remain still in their infancy[35].

The report is written in this background. First it will provide insights into practices of urban areas and how they are implementing water sensitive solutions in the context of increasing challenges related to water. Then it will contribute to the policy discourse with an elaboration of a set of recommendations that are targeted at decision-makers on different governance levels.

2. DEFINING THE FLOW

In the context of increasing water-related extreme weather events, this report investigates how governance mechanisms shape the implementation and potential mainstreaming of urban water resilience measures across Europe. Its objective is to provide empirically grounded insights into how cities and regions apply water-sensitive strategies to manage rainwater and adapt to climate pressures. By focusing on four case studies (Berlin, Bologna, Bordeaux, and the region of Lower Austria) the report explores the governance processes that enable or hinder the emergence of integrated, city-wide responses to rain-induced challenges such as flooding and water scarcity. Drawing on expert interviews, desk research, policy analysis, and academic literature, the report offers a critical perspective and concrete recommendations to support decision-makers at EU, national, and local levels in strengthening their policies for more water-sensitive urban futures.

For a city to effectively adapt to climate change and adopt urban resilience, it is necessary that urban climate change adaptation measures are not only showcasing projects but are also institutionalised and integrated into regular urban planning and services of local authorities. This process referred to as “mainstreaming” involves integrating these approaches as standard and sustainable components of urban policy rather than one-shot initiatives. This ensures long-term commitment to climate adaptation measures, moving beyond isolated lighthouse projects to address urban climate challenges in a structural and lasting way.

Thus, the research question is: **What governance dynamics influence the implementation and mainstreaming of urban water resilience measures in Berlin, Bologna, Bordeaux and Lower Austria?**

This question will be answered by adopting a comparative and multi-scalar lens, with a focus on concrete cases to better understand how governance structures of urban and regional systems respond to this dual challenge of water scarcity and flooding. This approach makes it possible to acknowledge that cities and regions operate under different institutional and environmental contexts. But at the same time, this enables identifying transferable insights between those European cities and regions that experience similar water problems.

The four selected cases to conduct this comparative analysis cover different territorial realities and policy contexts. Three cities (Berlin, Bologna and Bordeaux) and one region (Lower Austria) are compared. Indeed, this selection allows an investigation of a wide range of governance models, planning approaches, and technological solutions across diverse climatic, geographic, and institutional contexts.

2.a Rationale for the Selection of the Case Studies

Berlin, Bologna, Bordeaux and Lower Austria were selected as they respected a number of criteria, Governance, Geography & Climate, Water related issues, which will be listed shortly.

Firstly, the four selected areas present many differences, both from a climate as well as an administrative perspective. Starting with Berlin, which is a landlocked capital, very populous, city sitting on the banks of the Spree river. Berlin's very particular governance structure, given that it is a federal state, makes major decision-making processes very different from other major German cities, such as Munich or Cologne. Bologna is also landlocked, situated in the southern end of the Padana Valley, and is traversed by multiple rivers, streams, and canals. While Bologna is the capital city of the Emilia-Romagna region, the city itself does not have as many competencies as Berlin in terms of water management, as most of these are delegated to the regional authority.

Moving closer to larger bodies of water, Bordeaux is located at the mouth of the Garonne river, close to the Atlantic Ocean. The governance structure of this city differs greatly from the two above-mentioned ones as, due to centralisation, the majority of the decision-making processes take place at the national level. Lastly, Niederösterreich, or Lower Austria, was chosen due to it being a rather rural region, surrounding the capital of the country, Vienna. Similarly to Berlin, this Austrian State is rather independent from the others, albeit in this case it is formed by a compound of smaller cities which do not have as many competencies.

While differing greatly in many aspects, all of these cities are within the European Union and therefore operate within the same larger institutional framework that is based on European level regulations and directives.

Secondly, all of these four areas have recently experienced a great amount of water-related extreme events, both in the realm of flooding and of droughts, cases which have been increasing in all regions over the last few years, becoming more and more the norm. Despite experiencing similar water-related issues, the four areas have very varying approaches to water sensitivity and climate resilient solutions, which will be explained in detail in each city fiche in the report. These four areas have adopted different solutions based on the specific nature of their problems, the funding available, and the institutional framework of the country or region they are situated in, making for interesting case studies to analyse and compare.

Lastly, these four areas were chosen over four other cities, namely Malmö, Bristol, Wroclaw and Eindhoven, as the language skills and personal experiences of the authors aligned better with Bologna, Berlin, Bordeaux and Lower Austria, allowing for interviews to be conducted in the mother tongue of the civil servants and other interviewees. Nontheless, a brief analysis of these four cities can be found in the Annex of this report, as their innovative approaches to WSC and water management structures could be relevant for future researchers.

To conclude, the four areas were selected due to their diversity in governance structure, climate, and population size, as to provide for the widest possible range of existing approaches, while all sharing very similar water-related issues.

2.b Comparative Framework

We selected five key criteria to build a multi-dimensional analytical framework. This selection of criteria draws on an extensive body of literature that underlines the complexity of urban water management. Various scholars explain that comparative case studies must reflect both diversity and comparability in order to generate insights potentially transferable. Among these, Fournier et al. proposed a framewok emphasizing adaptative governance, highlighting the importance of multi-level coordination and institutional flexibility to adress water risks[36]. Rijke et al. developed the transition management perspective aiming at switching from reactive to proactive models through innoation, learning and cooperation[37]. Gralepois et al. introduced the "hybrid governance arrangements" in flood risk management, blending technical planning with participatory processes to foster legitimacy in decision-making[38].

These frameworks converge on several key insights and highlight the complexity of governance systems to navigating complec water challenges. It was helping in developing our own comparative framework.

Drawing on these insights, we identify several key patterns that inform our analysis. We identified a macro level focusing on understanding broader governance context and institutional landscape, including the roles of national, regional and local authorities. The meso level gives attention to governance processes and especially decision-making dynamics and stakeholder engagement. As for the micro level, it is looking at enabling and hindering factors (leadership, technical capacities, financial tools...) that influence implementation and resilience of water measures.

We picked the five following criteria covering a specific aspect of governance dynamics:

Governance, coordination & leadership
A first key dimension focuses on understanding how urban water resilience lies in the distribution of responsibilities between the different involved organisations. Assigning clearly the competences between municipal, regional and national level is essential. In addition, cross-sector collaboration, such as involving urban planning departments or climate adaptation offices, can be interesting to bring complete responses to complex water challenges. Nevertheless it is also often initiatives of individual politicians or other leaders from civil, public or private sector that drive innovations.

Public engagement & awareness
The second essential criteria is citizen participation in the implementation. Mechanisms of consultation or informal forms of civic mobilisation are both examined in this part. Evaluating the degree of public support is interesting to assess how communities relate to environmental risks and solutions. It is also important to compare how risks and actions are communicated to citizens whose own actions are often needed for cities to become resilient (e.g. owners of houses).

Data, knowledge & evidence-based action
In the implementation of policies and interventions, a great deal of data and technical knowledge is fundamental, requiring cross-sectoral knowledge sharing when managing water. This involves monitoring tools, mobilisation of expertise from academia, bottom-up surveillance, consulting, and more. The different mix of tools and levels of their implementation and use provide for an interesting comparison between cases.

Policy integration and strategic planning
Water resilience also implies being integrated within a broader urban, social and environment policies framework. It is essential to plan strategic water resilience actions in a long-term perspective and get away from project-based and short-term interventions. The degree of integration of water policy with other key domains like land use or housing reveals can give insights if holistic approaches exist within the urban context.

Resources, triggers & incentives
Local, national or European fundings can influence the scope and ambition of water resilience measures. Extreme weather events often trigger or accelerate policy processes leading to the release of funds or the reprioritisation of actions. Financial tools are also used to incentivised the private sector to engage in broader water senstive city strategies.

With these criteria we will be able to identify common patterns, innovative practices or barriers for mainstreaming across the selected case studies that will be presented in the city fiches.

3. TRACING THE FLOW

3.1 Expert Interviews

In order to gather more insights into the different allocated comparison areas and case studies we opted to set up interviews with different experts for each case. The research employed semi-structured interviews to gather perspectives on how water-sensitive measures are implemented and mainstreamed in cities, drawing on input from 17 stakeholders. This group included one EU policy expert, two academics, eight representatives from public administration, two elected city officials, and four industry experts or consultants.

A flexible, semi-structured questionnaire, informed by policy design literature, guided the interviews. This allowed us to lead open-ended discussions while exploring key themes like funding mechanisms, stakeholder engagement, leadership, and civil society involvement. Questions were tailored to each participant's expertise. Macro- and meso-level stakeholders, such as public officials and policymakers, focused on governance structures, systemic integration, and regulatory frameworks. Meanwhile, project-level actors like consultants and industry experts discussed challenges, barriers, and opportunities for mainstreaming innovative approaches.

Each interview began with an introduction to the research objectives, ethical guidelines, and anonymity assurances. Initial questions explored the participant's role and institutional context, transitioning into thematic areas such as urban challenges, project alignment with broader strategies, and governance models. Participants also discussed knowledge diffusion and strategies to foster collaboration across sectors.

The interviews concluded by inviting participants to share additional insights and suggest further contacts. This iterative process strengthened the findings, offering a comprehensive understanding of the governance and implementation challenges in advancing water resilience. The diverse perspectives highlighted systemic barriers and opportunities, shaping the study's analysis of pathways for improvement.

4. DIVING INTO THE CASES

4.a Berlin

4.b Bologna

4.c Bordeaux

4.d Lower Austria

CITY FICHE

OVERVIEW

Demographics

Berlin, a city-state and the capital of Germany, is home to approximately **3.74 million people** and spans an area of about **892 km²**[39]. Over the past decade, the city has experienced steady population growth, which has driven a significant expansion of residential areas—an 18% increase[40] [41] [42]. In contrast, urban green spaces, including public parks and forests, have expanded by just 3%. Nevertheless, **green and forested** areas still cover **more than 30% of the city's area**, providing crucial ecological and recreational value.

Population projections estimate an **additional 254,000 inhabitants by 2030**, prompting the planned construction of around **137,000 new housing units**[43]. This urban expansion places increasing pressure on Berlin's land use, particularly in the context of climate change. The city has already experienced more frequent heatwaves, droughts, and elevated temperatures in recent years.

Challenges

With about **34 % of the city area being impervious,** rainwater has limited ability to seep into the ground naturally. Berlin continues to grow, but its sewer system was not designed to handle extreme rainfall and can only be expanded with immense effort[44]. Berlin's combined sewage system which is common in many Western European cities handles both stormwater and wastewater. Increasingly frequent extreme weather events overwhelm this system, causing overflows into the Spree and negatively impacting water quality.

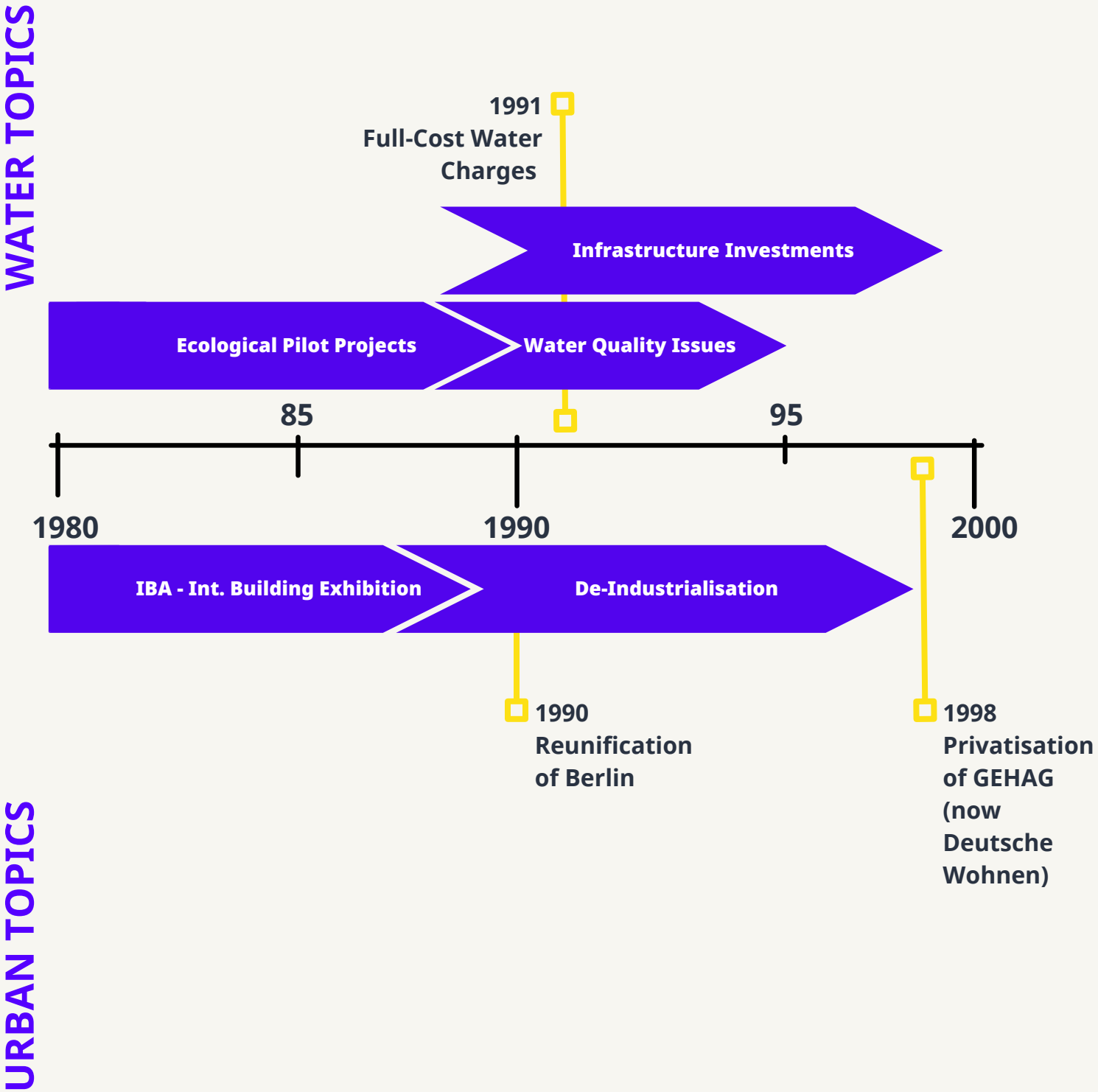
Water stress presents another significant challenge. Berlin sources its drinking water entirely from its own territory, making it vulnerable to future water shortages. The cessation of coal mining in Brandenburg and subsequent flooding of former mining sites will reduce inflows into the Spree River. Combined with declining rainfall due to climate change, this is expected to exacerbate low-water events and strain the city's water supply. Corroborating this is the fact that the Berlin-Brandenburg region is one of the areas in Germany with the lowest precipitation.

Governance

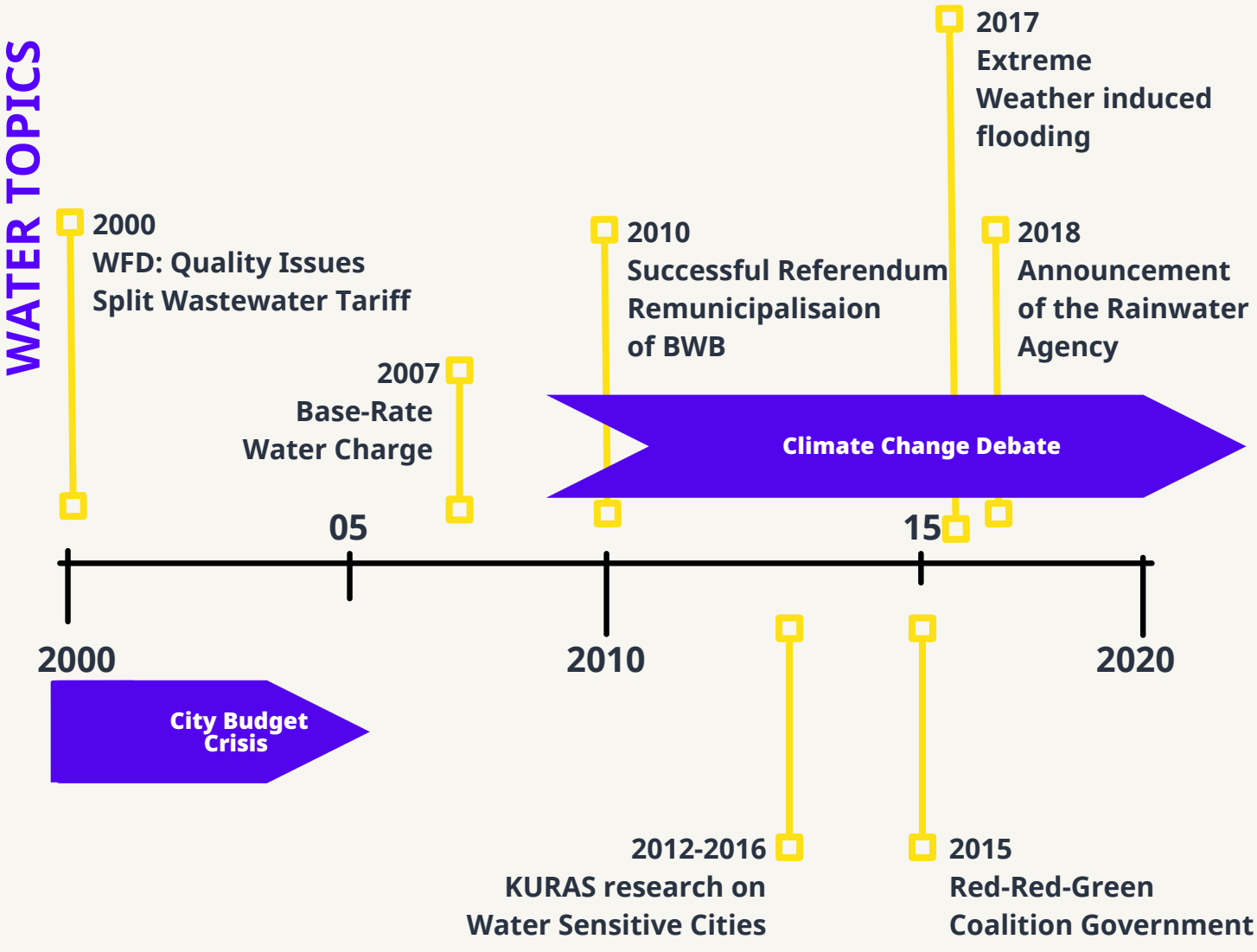
Berlin's government is actively preparing for these future challenges through the development of a comprehensive "Masterplan Wasser" (Water Master Plan) by the Senate, aiming to safeguard water resources and ensure the city's resilience in the face of ongoing environmental and demographic pressures[45].

Berlin Wasserbetriebe (BWB), also known as Berlin Water Company, is Europe's largest integrated water utility organisation. After having been partially privatised between 1999 and 2011 it is now again in public ownership by the state.

WATER SENSITIVITY ROADMAP



WATER SENSITIVITY ROADMAP



FINDINGS

Governance, Coordination & Leadership

The creation and increasing institutionalisation of the Rainwater Agency ensures that water-sensitive interventions are coordinated and mainstreamed across Berlin's administrative landscape[46]. Established in 2018 after a lengthy preparatory process, the Rainwater Agency functions as a pure coordination actor without its own financing or political power, relying instead on partnerships to drive its mission forward. Partially financed by the Berliner Wasserbetriebe (BWB) and Berlin's Senate, the Agency leverages these relationships to maintain operational stability and legitimacy.

Complementing the Agency's citywide remit, climate adaptation managers are emerging in Berlin's landscape. The first full-time employee started their work in January 2024, in Wilmersdorf Charlottenburg to coordinate among technical departments to integrate the city's climate adaptation strategy into local urban planning and infrastructure projects. Yet progress varies by commune, with some early adopters moving ahead of the needle (Charlottenburg-Wilmersdorf and Friedrichshain Kreuzberg) while others respond more gradually to the new Climate Adaptation Act, which mandates that all German communes develop and document climate adaptation strategies and measures. Here efforts depend very much on the political and socio-economical situation of the different communes.

Together, these initiatives exemplify the necessity of both horizontal integration between public administrations and vertical integration from national through to local levels to achieve transformative impact at scale.

Also informal groups have been having influence on Berlin's development. The "Berliner Wassertisch", an informal group of different stakeholders interested in topics such as sponge city concepts have been influentially pushing for increasing attention to the topic.

Public Engagement & Awareness

Through its annual Forum Regenwasser event, the Berliner Regenreihe educational series, Berliner Regendialoge expert talks, and competitions showcasing lighthouse initiatives, the Rainwater Agency provides regular opportunities for private, public, and civil-sector actors to come together, share insights, and forge new partnerships. As an institution in itself, the Rainwater Agency is attracting a lot of visibility for the topic.

By offering the "rain calculator" digital tool, the Agency also raises public awareness of the economic attractiveness of rainwater harvesting and treatment systems, helping citizens to understand both the environmental and financial benefits of water-sensitive design[47].

The BWB is only responsible to cover for 5 year flood events, anything after this owners of buildings need to adapt their buildings to be resilient, this important information, however is not well known, and poses a big challenge in the adaptation process.

Data, Knowledge & Evidence-Based Action

Universities play a pivotal role by supplying data and technological expertise to develop tools that enable practitioners and decision-makers to pinpoint at-risk areas and determine the most effective interventions. An illustrative example is the Rewanka research project, a collaboration between the Technical University Berlin and the commune of Wilmersdorf Charlottenburg, which has generated spatial analyses and modelling platforms to support targeted rainwater management strategies in Berlin's urban fabric[48].

GIS applications and Digital Twin technologies are also increasingly employed by public administration. Here, administrative barriers to using open source collaboration tools and limited expertise seem to hinder more integrated collaborations between technical departments.

The Kuras research project, funded by the BMBF, was pivotal in setting the frame for Berlin's path in developing a Rainwater Agency and decentralised rainwater management interventions[49].

Policy Integration & Strategic Planning

The Rainwater Agency's establishment forms part of Berlin's broader efforts to fulfil the European Water Framework Directive, embedding water-sensitive approaches into urban governance. It supports the implementation of numerous national and federal laws and regulations—including the Water Resources Act (WHG), the German Building Code (BauGB), the Berlin Water Act (BWG), and the BReWa-BE information sheet on limiting rainwater discharge in construction projects—ensuring legal coherence across scales.

Moreover, the Agency advances the objectives of Berlin's strategic frameworks, such as the StEP Klima climate adaptation plans (including StEP Klima KONKRET and StEP Klima 2.0), the SenStadtUm 2012 biodiversity strategy, and the SenUVK 2020a charter for urban greenery with its associated 2030 action plan (SenUVK 2020b)[50] [51]. It has also lent its expertise to the city's flagship subsidy programmes "1000 Green Roofs for Berlin" and its successor "GründachPLUS," embedding water-sensitive design into long-term greening efforts[52].

Resources, Triggers & Incentives

The creation of the Rainwater Agency and the necessary budgets were provided after a flood that had just happened after a new government was elected in 2018. The plans for the rainwater agency, as well as the data on where and how to intervene had been elaborated during the Kuras research project. This research project also had created a critical mass of researchers, practitioners and public administration actors that were all aligned behind spong city solutions as a means to tackle Berlin's increasing water-related issues in a holistic manner.

A key challenge in Berlin is to mobilise private owners of buildings to invest in water sensitive solutions. Subsidy programmes like "1000 Green Roofs for Berlin" and "GründachPLUS" provide financial incentives that spur private-sector investment in rainwater infrastructure. However, these seem not to be taken up as much as wanted according to civil sector organisations.

The Agency's "rain calculator" further underscores the economic viability of these interventions, using clear cost-benefit analyses to motivate property owners.
Another challenge are cross territory issues where water needs to be evacuated across different properties, here no real solutions have yet been presented, triggering conflicts and impeding public projects that require private collaboration.

The pace of local adaptation is accelerated by triggers such as the Climate Adaptation Act, which compels all communes to develop documented strategies and measures—prompting some districts to upgrade infrastructure promptly and others to follow suit more deliberately as they navigate their unique path dependencies.

BOLOGNA

CITY FICHE

OVERVIEW

Demographics

With nearly **400.000 inhabitants,** or 1 million when considering the metropolitan area, Bologna is Italy's seventh largest city, growing at a constant pace[53]. Once a medieval city, now a growing metropolis, Bologna is the capital of the Emilia-Romagna region, hosting several institutions as well as the world's oldest university, founded in 1088. The city's rich history, bustlin student life, and a thriving local economy based on small and medium sized enterprises, make the city constantly placed in the top 10 in the country for quality of life[54].

Challenges

The city lies at the southern edge of the Po Plain, sitting at the foot of the Apennine Mountains, surrounded by hills. While being only linked to the Po river through an artificial canal, the city lies at the conjunction of the river valleys of the Reno and Savona, which do not traverse the city directly but irrorate it with their numerous canals[55]. Many of these canals run beneath the city's surface, sometimes incurring in limited capacity of water flow and structural issues.

Bologna's climate is humid subtropical, already facing numerous effects of climate change. The number of tropical nights, meaning nights with a mean temperature above 20 C, has been constantly increasing over the past decades. Additionally, a **decrease of about 10% of annual rainfall** is expected to take place **between now and 2050**, with longer periods of drought paired with more intense rainfall events, concentrated particularly during autumn, affecting agriculture and water supply during the summer[56].

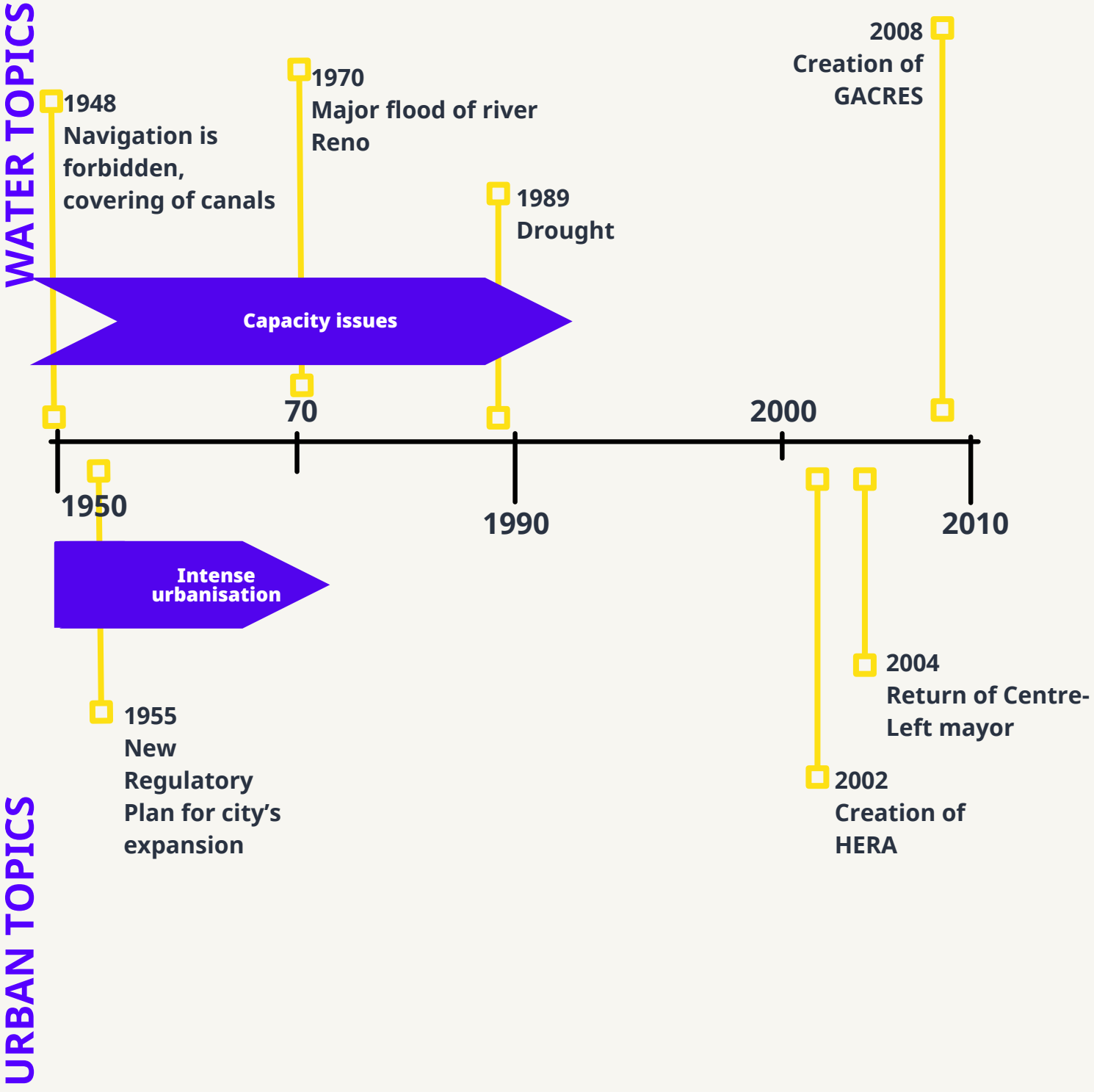
This, combined with a very dense medieval urban core implies not only heat risk for the population, but a combination of increased flood risk during the cold seasons and drought risk during the warm ones.

Bologna has faced **several floods** throughout its history, but the number and intensity of these is on the rise, as the events of **2019, 2023, and 2024** have demonstrated.

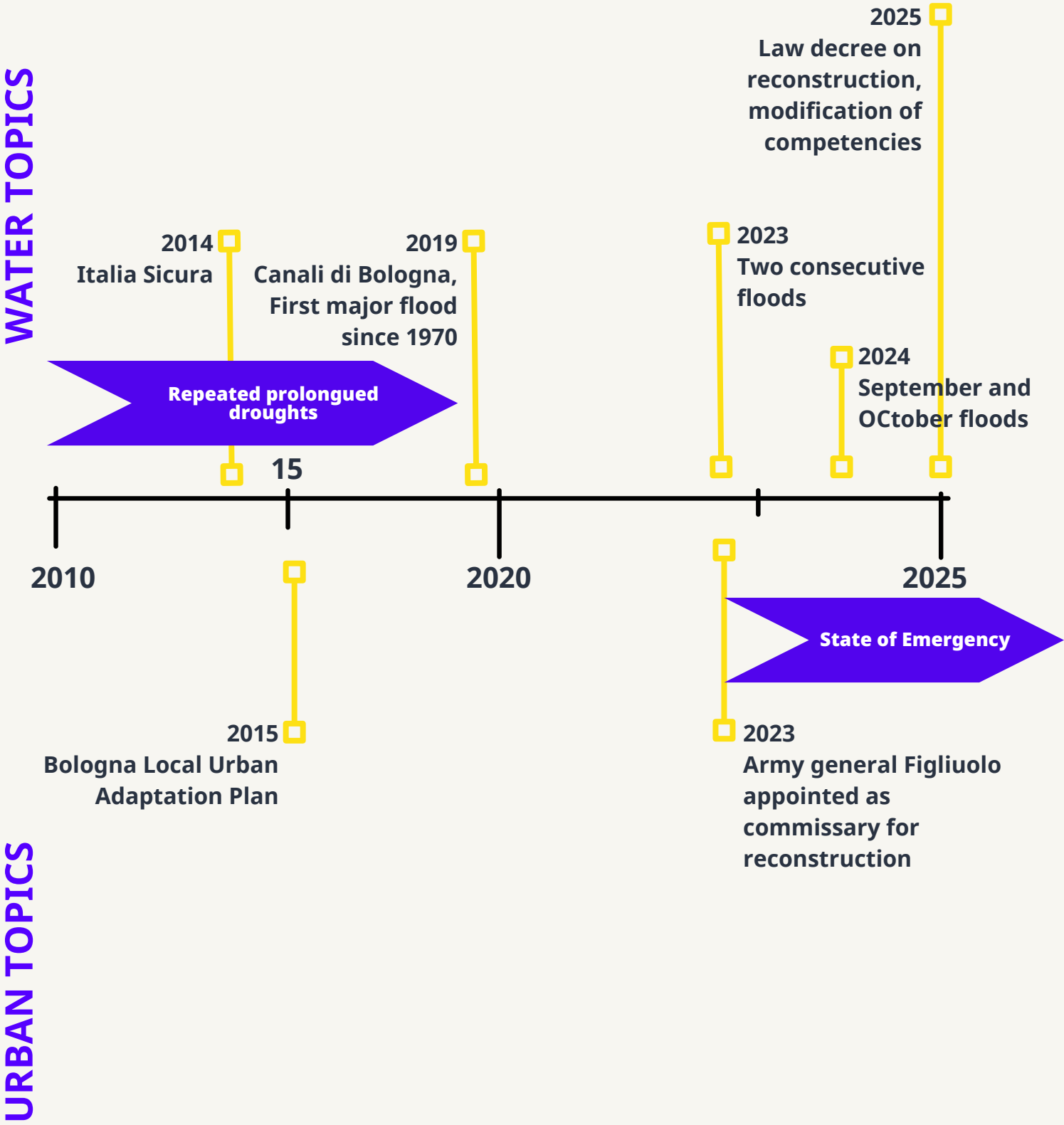
Governance

Within the national context, Bologna is the capital of the province of Bologna and the Emilia-Romagna region. After the reform of 2014 the majority of the province's competences were moved over either to the metropolitan city or to the region. In terms of water competences, the majority of them reside in the regional and local bodies, with the state only intervening in case of emergencies. Water management in Bologna is quite fragmented, with some very unique entities being part of the framework. The region has the delegation over the property of the rivers that flow into and out of the city's territory (albeit not within the city proper), such as the Reno and Savona as well as other minor streams. The region, among other things, has jurisdiction over the protection, regulation, and utilization of water resources.
The jurisdiction over the water flowing through the city itself belongs to Canali di Bologna, a complex entity with very specific juridical definitions. Bologna lies in the Reno river basin, meaning its management is conducted in collaboration between the City of Bologna, the Consorzio dei Canali, and the Civil Protection of Emilia-Romagna. Lastly, water supply in the city is handled by Hera SpA, a multi utility bringing together both public and private actors.

WATER SENSITIVITY ROADMAP



WATER SENSITIVITY ROADMAP



FINDINGS

Governance, Coordination & Leadership

The long historical process of waterways-building has led to today's particular water management structure. The Consorzio della Chiusa di Casalecchio e del Canale di Reno (Consortium for the lock of Casalecchio and Reno canal) created in 1851 and still active today, is an independent body that regulates and maintains water provision in the artificial canals system[57]. The consortium and its members have full jurisdiction and property over the canals, and act independently from, but often in collaboration with, the city council and HERA. In an effort of resource sharing and operational synergy, the Gestione Acque Canali Reno Savena (G.A.C.R.E.S.) was created in 2008, acting as the sole manager and operational arm of the various canals consortia[58]. It carries out its activities in the interest of the consortia, acting as a shared resource.
The three canals consortia and the GACRES were brought together under the Canali di Bologna in 2019, with the objective of ensuring hydrogeological safety and managing the regulation of flows during periods of prolonged droughts or floods[59].

The leadership role has been gradually being taken by the city of Bologna, which is always more trying to act as a unifying actor bringing stakeholders together. To that is added the recent turn towards participatory methods, which is a priority of the current council. The gradual integration of water management into Bologna's urbanistic and climate adaptation plans show a clear commitment of the administration to address the situation more holistically. Bologna's leadership particularly emerges during summer by hosting the roundtables for water resources allocation among the various entities.

Difficulties emerge in times of emergency when differences in political views and distance between institutions often hinder reconstruction processes. The interviews have revealed how more often than not the disagreements arise not from differing technical approaches, but simply from opposing political parties.

This shows how further integration is desired and necessary, both horizontally and vertically. Horizontally, the various municipal and local entities need to compromise on their needs for water in an institutionalised manner, a job currently being done by the city council. Vertically, a desire for more coordination between central state and local governments has been expressed by the interviewees and local authorities alike.

Public Engagement & Awareness

The floods of 2023 and 2024 have shown a low level of public awareness in terms of location of waterways[60]. In certain instances, some waterways run under homes and buildings built throughout the 1900s, with owners often being unaware of their presence.

Bologna is in the process of developing and improving a more participatory approach in this regard, as it was shown starting with the collaboration pacts and the Piano urbanistico generale (Pug), which wants to provide concrete interventions, approved and to be done through a very participative approach involving both public and private entities, as well as industry and citizens. In an effort to raise further awareness, the council is hosting meetings with the citizens to inform them about the risks and their duties in case of another emergency.

On October 14th 2024, the city has additionally introduced an Alert System, which notifies citizens residing nearby dangerous waterways about a possible overflow through a notification on their mobile phones.

Data, Knowledge & Evidence-Based Action

The flood of 2024 revealed a lack of monitoring data on the flow of minor ghost rivers that traverse the city. The main focus until 2024 was on major waterways (Reno and Savona), as they were the ones which overflowed more often in the past. With its exceptional precipitation and intensity level, the event of 2024 led to the explosion of several buried canals in the city centre, causing millions of Euros in damages and the endangerment of civilians. An effort was made in 2023 with the CreDiT project, but evidence shows that data collection is still to be improved, which is why a new monitoring and alert system is currently under development.

More recently, a politically controversial system of “bottom-up” monitoring has been introduced, giving citizens the possibility to alert authorities of abnormalities in the waterflow of specific canals[61].

An effort to unify data collection and alert systems between regions, as well as simplifying the procedures for climate adaptation works was first made in 2014, with the creation of the Italia Sicura agency. In an optic of holistic prevention, rather than case-by-case mitigation, the agency provided a country-wide overview of the risks and weaknesses faced by the territory. The agency was closed with the following government, stopping the progress made in data sharing between regional and provincial entities[62].

Policy Integration & Strategic Planning

In 2015 Bologna was among the first Italian cities to draft a Local Urban Adaptation Plan for a resilient city (BLUEAP) in coordination with LIFE, EU’s funding instrument for the environment and climate action63. The BLUEAP was then integrated into the Piano d'azione per l'energia ed il clima (Paesc) (Plan of action for energy and the climate) focusing on analysing and addressing the growing issues of urban heat island effect, extreme weather events, and droughts[64].

In the wake of three major flooding events happening in the span of one and a half years, the current and main focus of Bologna and the Emilia Romagna is on reconstruction and damage control, which will be followed by adaptation and mitigation in a second phase of the 12 year-long Piano speciale definitivo per la ricostruzione (definitive special plan for reconstruction)[65]. The plan, approved and drafted by the central state, as the region was declared to be under state of emergency until October 2025, is envisioned to remain flexible and adaptable to evolving circumstances[66].

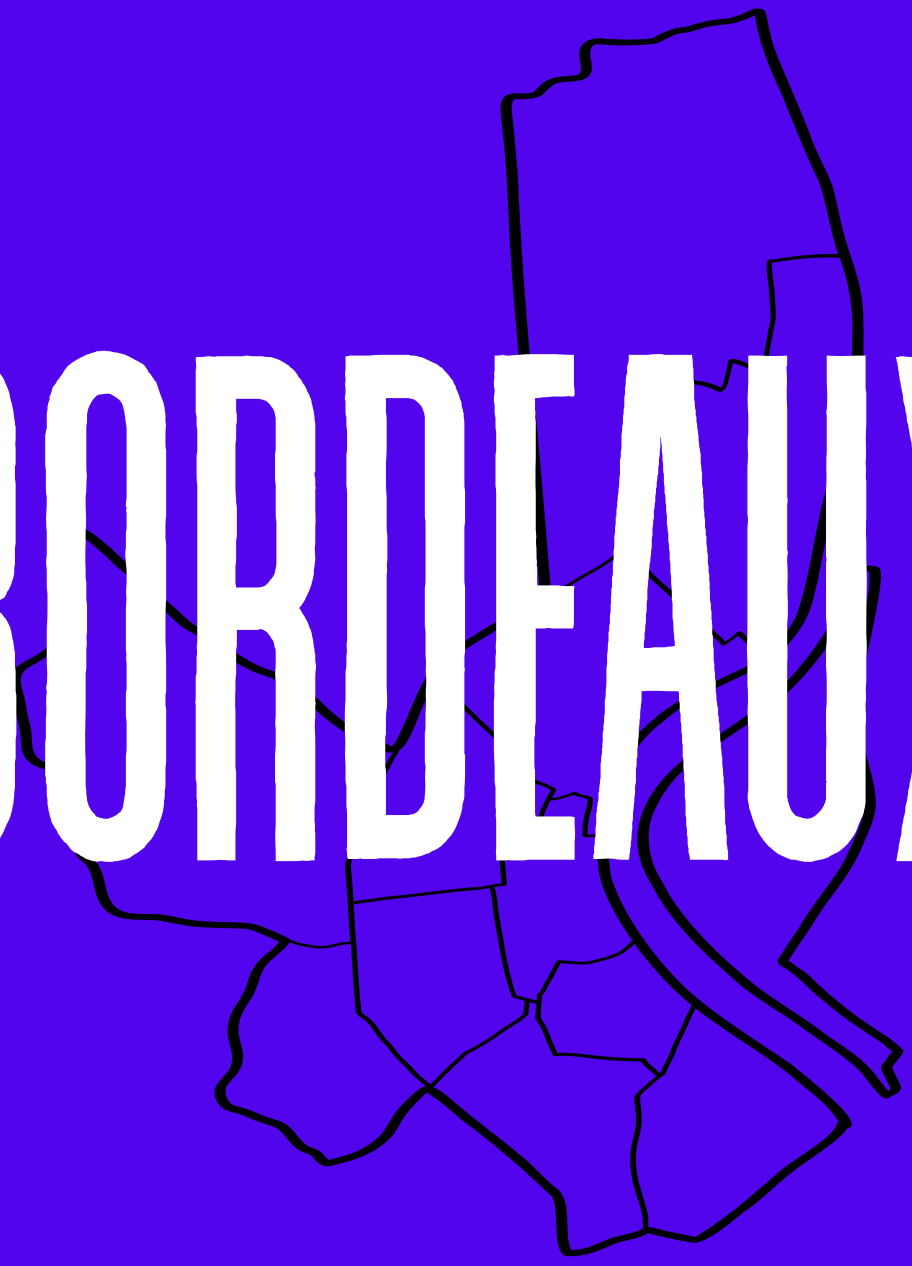
On the local level, there has been a recent integration of water management and urban planning, as is the case of the construction of the new tram network. In parallel to the remaking of the streets, several sections of underground canals are being brought back to surface for better drainage, eased waterflow, and beautification of the dense urban center.

Resources, Triggers & Incentives

The majority of resources to respond to the emergency were made available by the state, and partly by the region and the EU’s solidarity measures. In the case of Bologna the floods acted as a trigger for an acceleration in resource allocation and plan adaptation, with several billion Euros being allocated to the city and the region as well as the creation of the ad-hoc plan. The most recent Law Decree on post-flooding reconstruction, approved on April 30th 2025, allocates special funding and expedited procedures for private entities and families that were damaged by the floods, as well as technical aid for the reconstruction of buildings[67].

Funding opportunities in ordinary circumstances have derived from the region or the EU through the LIFE and CreDiT programmes, despite interviews revealing very little direct communication existing between the city and EU authorities.

BORDEAUX



CITY FICHE

OVERVIEW

Demographics

Located in the southwest of France, Bordeaux is the capital of the Nouvelle-Aquitaine region, the largest administrative region in the country since the 2016 territorial reform. The city lies along the **Garonne River**, approximately **50 kilometers from the Atlantic Ocean**, which embodies a strategic urban center with strong historical links to maritime trade and fluvial navigation. In addition to the Garonne River, the Dordogne river is also a river crossing the northern municipalities of the métropole. The metropolitan area encompasses 28 municipalities with a dense city center, peri-urban zones, and rural fringes, reflecting broader trends in urban sprawl and metropolitan governance in France. With a total population of 750 000, **250 000 live in the city** proper.

Challenges

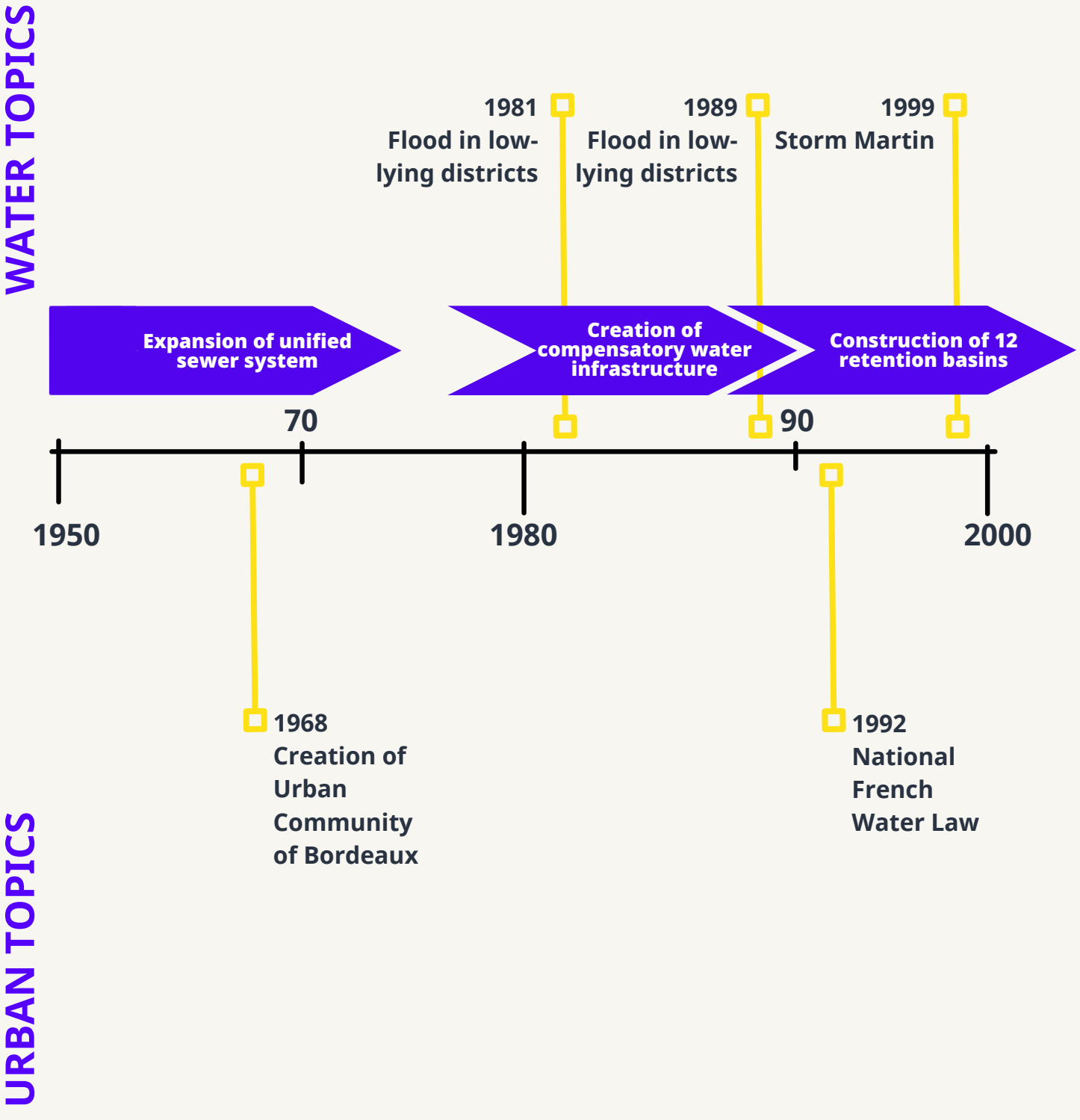
Because of its specific geographical location, Bordeaux is currently experiencing increasing rainfall in the last 30 years (increase up to 20%)[68] [69]. In addition to a warm oceanic climate, its geographic features make the region flood-sensitive: three-quarters of the metropolitan territory lie in a basin divided by the Garonne River, with many zones situated below high-water levels[70].

Importantly, water governance in Bordeaux is not treated in isolation but is increasingly approached as an interdisciplinary challenge, requiring coordination across fields such as urban planning, climate adaptation, civil protection, and biodiversity. The city is actively seeking to mainstream water resilience into spatial planning, ensuring that urban development, zoning, and land use policies support hydrological stability. This involves collaboration between engineers, urbanists, ecologists, and political actors across metropolitan and municipal scales. Recent institutional innovations reflect this ambition for cross-sectoral integration, as Bordeaux aims to align infrastructure investment with long-term territorial resilience.

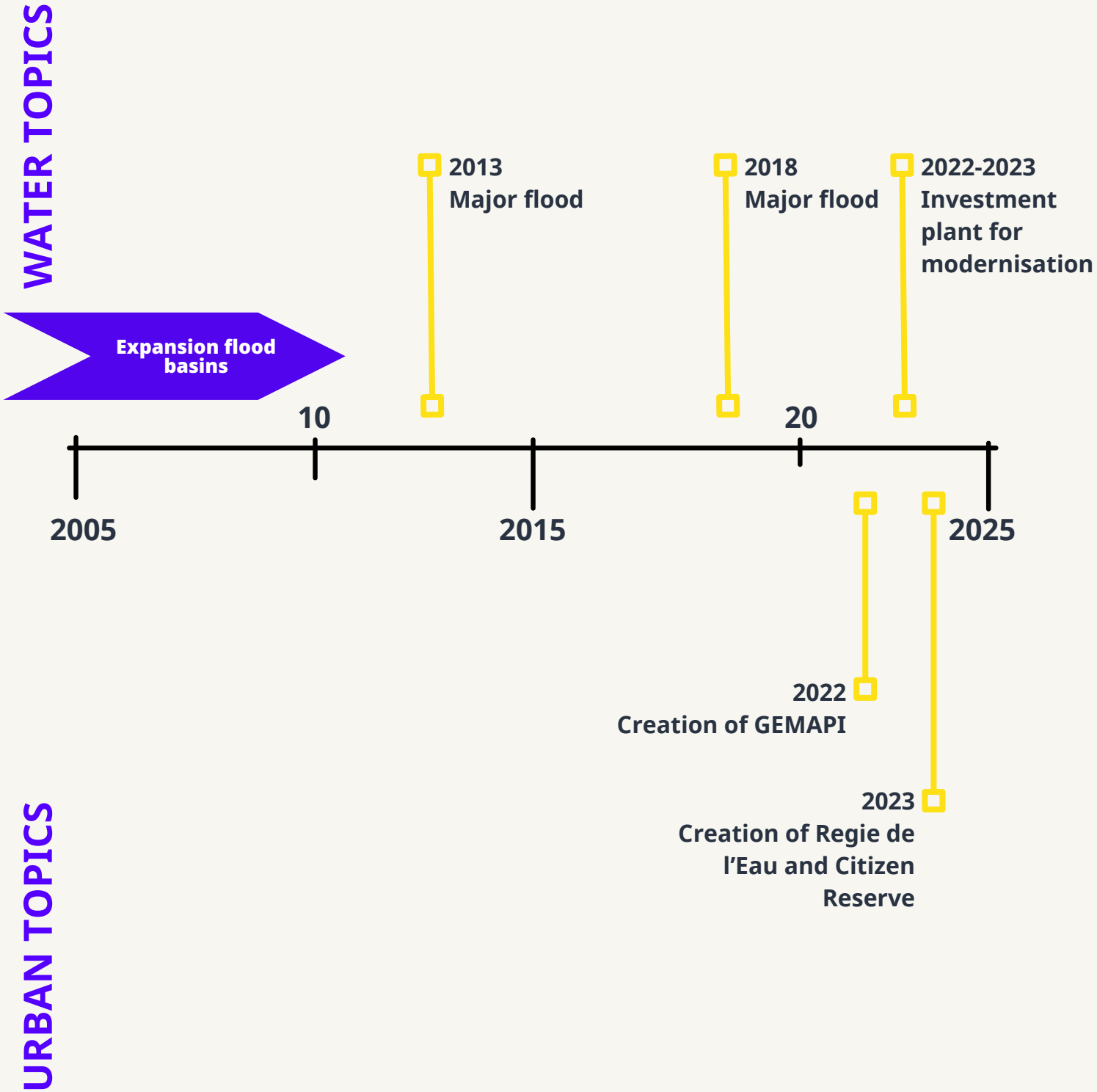
Governance

Being the sixth-largest metropolitan area in France, Bordeaux Métropole plays a significant role in the national urban hierarchy, especially with its economic dynamism and demographic growth. However, due to France's highly centralized and unitary political structure, local and regional authorities often operate with little autonomy, particularly in matters related to strategic planning and resource management. Indeed, national legislation is extensive and often transposed into regional or local regulations within a tightly controlled legal framework[71]. Bordeaux's water governance is thus a multi-layered governance system requiring careful coordination between the municipalities, metropolitan services, basin-level authorities like the SMIDDEST (syndicat Mixte Pour le Développement Durable de l'Estuaire de la Gironde) and national level.

WATER SENSITIVITY ROADMAP



WATER SENSITIVITY ROADMAP



FINDINGS

Governance, Coordination & Leadership

The organization of Bordeaux Métropole is a complex multi-level governance system for urban water management. Since 2016, the metropolitan service of GEMAPI has the legal responsibility for flood prevention, dike infrastructure, and ecological watercourse maintenance[72]. While Bordeaux Métropole coordinates strategic planning and operational response, local mayors of the 28 municipalities still remain influential as being part of the metropolitan council[73]. As the political decision-making body, the metropolitan council sets out the main priorities and directions for water management within the Métropole. This includes approving budgets for flood prevention, defining technical standards for water-related infrastructure, and formally adopting urban development plans that incorporate water resilience goals. The council also votes on strategic documents such as the PPRI (flood risk prevention plan) and the GEMAPI action plans, and ensures that municipal projects align with metropolitan resilience objectives[74].

Bordeaux's water management framework is tightly linked to the national level framework that provides additional layers of governance through legal frameworks (e.g., PPRI, PAPI) and funding mechanisms (Barnier Fund and EU funds). Leadership is shared but fragmented, requiring significant coordination between municipal actors, metropolitan services, and basin authorities like the SMIDDEST. The creation of the Resilience Mission and the internal structuring of GEMAPI into strategic and operational branches illustrate growing institutional leadership, though political fragmentation and overlapping competencies still pose coordination challenges[75].

Public Engagement & Awareness

Citizen engagement in Bordeaux's urban water governance is quite developed. Formal participatory processes have been implemented in infrastructure planning, especially for dike reinforcement and watercourse naturalization with public consultations and workshops[76] [77]. The "Citizen Reserve" embodies a pioneering civic volunteer program, illustrating an innovative approach to community mobilization, contributing to both crisis preparedness and public awareness[78]. But there is definitely a gap between institutional expectations and public perception: many residents remain unaware of flood risks, the presence of dikes, or the legal implications of floodplain regulations. To address this, Bordeaux launched initiatives like the "Resilience Month," aiming to improve risk culture and enhance awareness. However, in some instances, citizen involvement remains limited to informational campaigns, lacking mechanisms for deeper deliberation or feedback. Overall, public engagement is increasingly acknowledged as a necessary component of legitimacy and effective implementation but remains uneven across projects and services.

Data, Knowledge & Evidence-Based Action

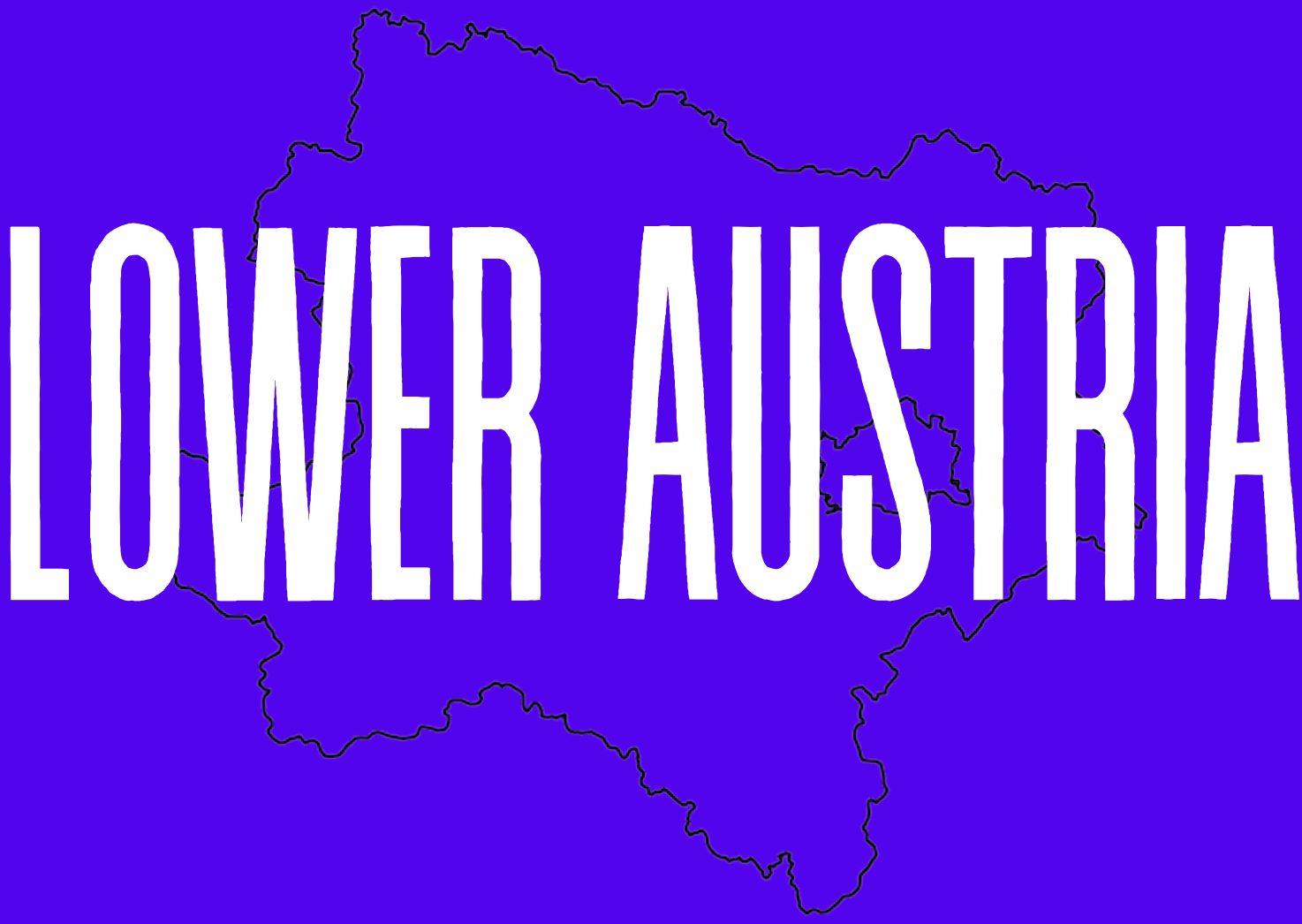
Bordeaux Métropole relies on a lot of technical knowledge and monitoring tools to inform its water resilience strategies. Services like the Régie de l'Eau have developed expertise in developing stormwater basin modelling and infrastructure performance monitoring[79]. Moreover, resilience projects are often based on scientific studies and planning documents supported by European research funding. The transversal nature of urban water issues has pushed Bordeaux to increasingly integrate expertise from sectors such ecology, and urban planning. However, institutional silos and procedural rigidity can hinder effective cross-sectoral knowledge sharing and adaptive governance.

Policy Integration & Strategic Planning

Water resilience in Bordeaux is more and more integrated into urban and environmental frameworks. There have also been efforts to align water-related objectives with policies of climate adaptation, biodiversity, and land use. Especially with the arrival of green coalitions in political governance, there has been increased emphasis on de-impermeabilization, nature-based solutions, and climate-sensitive urban planning[80]. However, integration remains partial and often constrained by rigid regulatory frameworks and project-based funding logic. The metropolitan government continues to navigate tensions between long-term resilience goals and short-term political or development pressures.

Resources, Triggers & Incentives

Funding for water resilience in Bordeaux originates from a mix of local (GEMAPI tax), national (Barnier Fund), and European sources (LIFE)[81]. While studies benefit from robust financial support, infrastructure implementation remains constrained by fragmented budgets and strict legislation. Extreme events such (2022 wildfires and heatwaves especially) served as critical triggers and enabled water management measures to be promoted[82] [83]. However, those reactive measures can limit proactive long-term engagement. There is also limited involvement of private actors, despite some efforts to integrate industries into resilience planning. Overall, while Bordeaux benefits from multi-source funding and institutional innovation, the sustainability and scale of investments remain dependent on overcoming structural and political constraints.



LOWER AUSTRIA

CITY FICHE

OVERVIEW

Demographics

Lower Austria, one of Austria's nine federal states, covers **19,000 km²** and has **1.67 million residents**, making it a key region in the country, which has a total population of 8.86 million and spans 84,000 km². The **capital, Sankt Pölten**, has about 56,000 residents. German is the official language. The State Parliament of Lower Austria (Landtag von Niederösterreich) has functioned in its current form since 1861, with roots in medieval assemblies (Landtaiding). The state is divided into **24 districts and 573 municipalities**, providing a decentralized governance structure[84].

Challenges

Lower Austria has a deep connection with water, shaped by both its geography and history. The Danube River, which flows for 286 kilometers through the region, carves its way from the Upper Austrian border to Slovakia[85]. Along its course, it passes through iconic landscapes like the Nibelungengau and the Wachau Valley, the latter a UNESCO World Heritage site[86]. These areas, shaped by centuries of human interaction, are central to the region's cultural and natural heritage. The Danube also supports recreational activities, with the Danube Bike Path drawing cyclists from across Central Europe[87].

However, Lower Austria's relationship with water is not without challenges. Due to climate change the region faces challenges from higher temperatures, more frequent droughts, heavy rainfall, storms, and hail, requiring comprehensive solutions[88]. Lower Austria has experienced severe flooding, with some residents rebuilding their homes multiple times in recent decades. The 2002 floods displaced thousands and overwhelmed emergency shelters, highlighting the ongoing vulnerability of communities[89]. The last flooding event significantly affecting the Lower Austrian region occurred in September of 2024, causing around €1.3 billion in damages in the whole country[90]. Conversely, the environmental activist group Greenpeace has identified 471 municipalities across Austria at high risk of acute water scarcity by 2050, with more than half of these located in Lower Austria[91]. The impacts of these floods and droughts continue to resonate, demonstrating the dual role of water as both a life-giving resource and a significant risk.

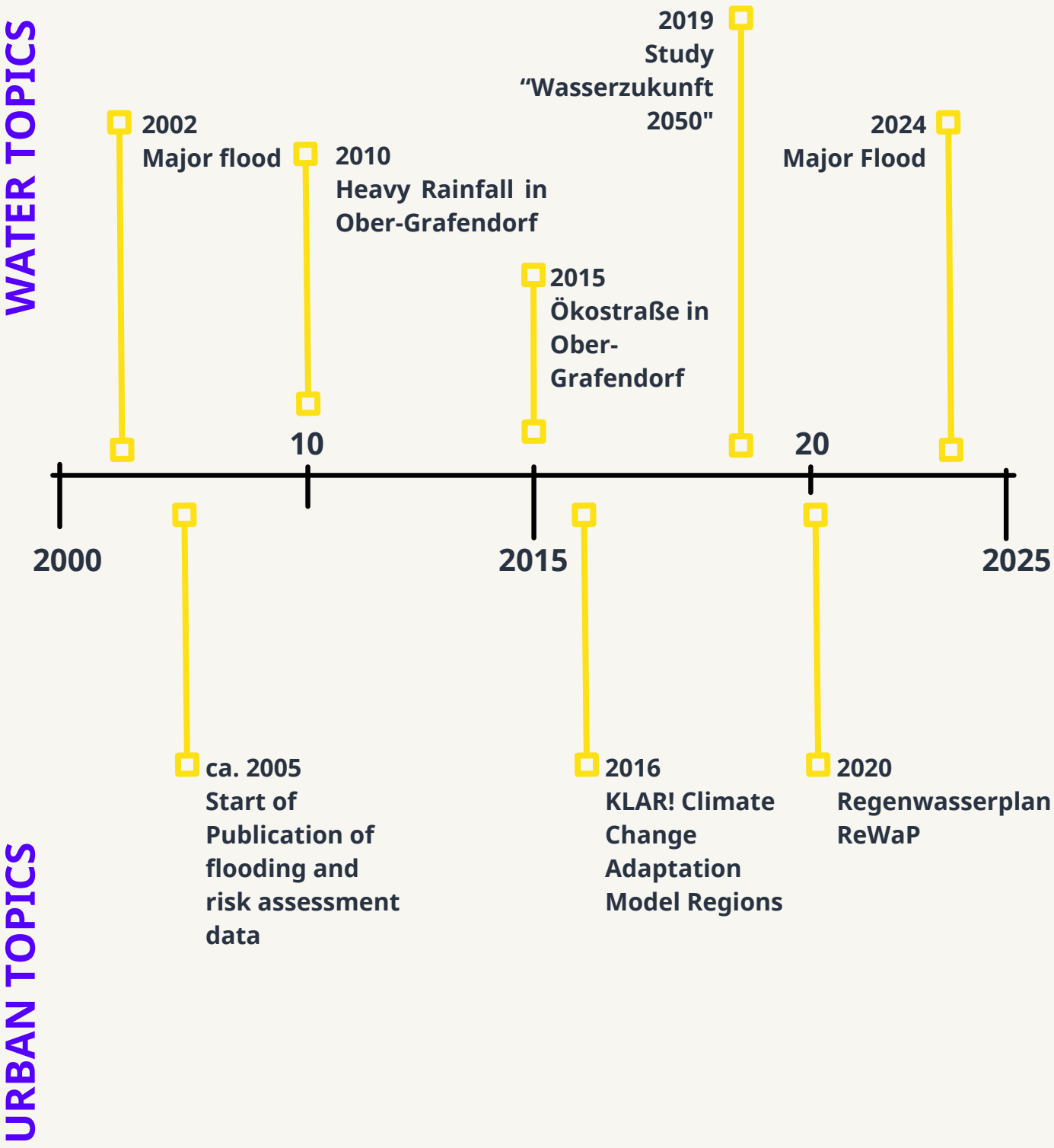
Governance

Lower Austria's governance is structured around its legislative and executive institutions, reflecting Austria's federal political system. The State Parliament (Landtag von Niederösterreich) is the primary legislative body, composed of 56 members elected every five years. These representatives operate under a free mandate, ensuring independence in their roles, and enjoy immunity to perform their duties effectively[91].

The Landtag's competencies are defined by the Austrian Constitution and include legislative authority over regional issues such as building regulations, regional planning, public administration, traffic laws, and environmental protections. It also oversees the state budget and holds the state government accountable, supported by the independent Lower Austria Court of Audit.

The executive power is led by the governor (Landeshauptmann), appointed by the State Parliament. The governor heads the state government and represents Lower Austria externally. For decades, governance in Lower Austria has been shaped by the Austrian People's Party (VPNÖ), with Johanna Mikl-Leitner serving as governor since 2017.

WATER SENSITIVITY ROADMAP



FINDINGS

Governance, Coordination & Leadership

Lower Austria implements climate adaptation strategies through the KLAR! (Climate Change Adaptation Model Regions) program, launched nationally in 2016. Funded by the Austrian Climate and Energy Fund, KLAR! equips municipalities with a structured framework to tackle the increasing local impacts of climate change, including temperature rises almost double the global average since 1880. At the regional level, Lower Austria's climate and environmental agency partners with municipalities to deliver these initiatives, using funding and support from the federal program. The KLAR! programme follows a phased approach. Initially, regions submit a general concept, and upon approval, develop detailed adaptation plans with at least ten specific measures. Over the next two years, these measures are implemented, with a continuation phase allowing further development, implementation, and monitoring. Lower Austria's climate agency acts as a central facilitator, providing expertise, sharing best practices, and fostering innovative approaches through international projects like SmartCommUnity and ARCADIA.

The "Regenwasserplan (ReWaP)" (Rainwater Plan) is a planning tool introduced in 2020 by the Department of Urban Water Management of the Lower Austrian State Government to assist municipalities in sustainable rainwater management. The governance framework begins with an analysis of the current state in the target area, identifying challenges such as heat islands or water scarcity. Municipalities, in collaboration with state department representatives and professional planners, define priorities and propose site-specific measures.

The study "Wasserzukunft Niederösterreich 2050" (Water Future Lower Austria 2050) serves as a critical governance tool for Lower Austria, enabling informed decision-making on water resource management. By projecting groundwater demand and availability across 11 regions, it helps identify areas at risk of water scarcity by 2050, such as the southern Vienna Basin and Weinviertel, where usage may exceed 80% of available resources.

Public Engagement & Awareness

The KLAR! initiative aims at strengthening the Austrian climate strategy at the regional level, raising public awareness, preventing maladaptation, and enhancing resilience by integrating federal funding with targeted local actions.

The Lower Austria Administration (Gruppe Wasserwirtschaft) provides public access to maps displaying flood-prone areas and hazard zones, allowing residents to assess their homes' vulnerabilities. These maps, available through the NÖ-Atlas, outline flood extents for 30-, 100-, and 300-year events, with larger floods covering broader areas. For wild streams, red and yellow zones indicate high-risk regions. Residents can download digital Geographic Information System (GIS) files or view analog versions at regional water management offices.

Data, Knowledge & Evidence-Based Action

Funded by the Austrian Climate and Energy Fund, KLAR! equips municipalities with a structured framework to tackle the increasing local impacts of climate change, including temperature rises almost double the global average since 1880.

The Lower Austrian Administration furthermore provides detailed flood maps that include data such as water depths and flow velocities for 46 waterways, enabling precise risk assessment. Updates are ongoing to ensure accuracy and relevance. The study "Wasserzukunft Niederösterreich 2050" helps identify areas at risk by 2050 and has been done by the administration and a local University (BOKU).

Policy Integration & Strategic Planning

In Lower Austria, the KLAR!-programme, which focuses on nature-based solutions, is aligned with local climate goals such as Target 6 of the "Klimakompass" (Climate Compass) (Target 6: 10% of public spaces are designated as biodiversity areas).

The "Regenwasserplan (ReWaP)" outlines actionable measures but does not cover their implementation, which occurs separately. These structured strategies ensure alignment between regional and federal policies, strengthening the overall climate adaptation framework.

Resources, Triggers & Incentives

An Ökostraße (Eco-Street) is an eco-friendly street design that incorporates decentralized rainwater management. Instead of directing rainwater into conventional drainage systems, the Ökostraße uses adjacent green spaces to absorb, store, and evaporate water through vegetation. These green strips are planted with perennials, shrubs, and regional trees like Dirndl bushes, which support biodiversity and provide cooling effects through evapotranspiration. Implemented in 2015 in Ober-Grafendorf along a 100-meter residential street, the project was part of the EU C3-Alps pilot initiative. Funded through the municipal budget, its costs were comparable to traditional roadworks, as it utilized areas otherwise allocated for standard roadside greenery.

For the "Regenwasserplan" (Rainwater Plan) Financial support is available through the Lower Austrian Water and Wastewater Fund (NÖ WWF), covering up to 40% of planning costs. Municipalities must apply before beginning work, submitting a brief project description, budget, and planner's proposal.

5. COMPARING THE CASES

By comparing Berlin, Bologna, Bordeaux and Lower Austria, we observe four distinct trajectories in how urban and regional authorities confront intertwined challenges of flood risk, drought vulnerability and aging water infrastructures—all under mounting pressure from climate change.

Governance, Coordination & Leadership

Bologna's water governance remains a mosaic born of centuries of canal engineering: three historic canal consortia (now unified as Canali di Bologna), the metropolitan city council, the Emilia-Romagna region (owner of surrounding rivers), and HERA SpA (a public–private multi-utility) share overlapping competences. Only during declared state emergencies does the central Italian government inject new authority—and funds—to steer reconstruction. In contrast, Berlin has chosen a partnership-oriented model: its Rainwater Agency (est. 2018) functions as an advisory and coordination hub that is backed by the Berlin senate, the main water utility provider, Berliner Wasserbetriebe (BWB) and is also respected by emerging district adaptation managers and civil-society networks like the "Berliner Wassertisch." Without its own budget or enforcement powers, the Agency relies on regulation (especially on the BReWa-BE law, that requires the decoupling of rainwater infiltration from the combined sewage system) and informal alliances to mainstream water-sensitive urban measures.

By comparison, Bordeaux has rigorously consolidated authority through two recent statutory innovations. GEMAPI (2022) wields legally mandated responsibility for aquatic environments and flood prevention across its 28-commune Métropole, while the Régie de l'Eau (2023) re-municipalized drinking-water services, replacing private operators and aligning water supply with resilience goals. A "Citizen Reserve" resilience unit further integrates municipal departments and citizen volunteers. Finally, Lower Austria operates at a regional scale: the democratically elected Landtag enacts water and environmental statutes, and state agencies (e.g. Klima- und Umweltagentur) enable local adaptation through competitive grants (KLAR! 2016) and planning tools (Regenwasserplan 2020). Though it lacks a single, centralized water authority, the state's extensive hydrological risk maps and scientific studies (Wasserzukunft 2050) provide a shared foundation for decentralized municipal action.

Public Engagement & Awareness

Berlin's approach to awareness-raising is heavily expert-driven: annual forums, technical dialogues and a digital "rain calculator" engage planners, architects and building owners—but many residents remain unaware of their obligations under flood-liability rules. Bologna has experimented with participatory "Patti di collaborazione" and roundtables during droughts, yet public involvement still spikes reactively in the aftermath of floods (notably in 2019, 2023 and 2024). Bordeaux contrasts sharply, having embedded citizen volunteers in its "Citizen Reserve," run educational campaigns at flood basins, and opened water-risk maps for community use—fostering a visible emotional connection to local waterways. Lower Austria likewise provides open-access flood-hazard maps (NÖ-Atlas) and disseminates planning brochures, but direct citizen participation beyond these data tools remains modest.

Data, Knowledge & Evidence-Based Action

Bordeaux benefits from decades of hydrological monitoring, leveraging sensor networks, dike performance data and scientific advice from INRAE and regional agencies to inform both basin design and land-use zoning. Lower Austria's "Wasserzukunft 2050" projections—paired with detailed groundwater and flood-risk GIS layers—give municipalities a robust evidence base, which is updated regularly through state-sponsored research. Strong research partnerships underpin Berlin's interventions: Especially the finished KURAS projects generated a lot of data and concepts on how Berlin could become a water sensitive city, it also created stakeholder consensus, that later shaped the Rainwater Agency's mandate. However, the usage of newer technologies, like open source GIS applications or digital twin planning tools is still in its babysteps, hitting administrative silos and barriers. Bologna's medieval canal network suffers from limited real-time monitoring; only recent EU-funded "CreDiT" digitization efforts and the integration of BLUEAP data into the city's energy-climate plans have begun to fill that gap. Additionally, recently introduced bottom-up monitoring initiatives are aiming at filling this knowledge and data gap.

Policy Integration & Strategic Planning

Berlin embeds water resilience within its broader climate-adaptation framework: the Climate Adaptation Act, Masterplan Wasser and biodiversity strategies (SenStadtUm, SenUVK) collectively channel subsidies for green roofs, sponge-city retrofits and decentralized infiltration systems. In Bologna, the Local Urban Adaptation Plan (BLUEAP 2015) and its subsequent integration into the Paesc and the General Urban Plan (PUG 2020) align heat-island mitigation and SUDS objectives, yet lack binding enforcement or dedicated financing outside emergency decrees. A leap forward in longer term policy integration is currently in the making with the 12 year-long definitive special plan for the reconstruction which is expected to be published in June 2025. Bordeaux stands out for explicit, long-term vision with a ten-year and €120 million infrastructure modernization strategy and ecological restoration targets, ensuring that each new development reinforces hydrological stability. Lower Austria situates water adaptation within its regional climate-energy roadmap (Klimakompass), tying it to land-use and biodiversity goals; implementation is flexible yet dependent on municipal capacity and competitive grant cycles.

Resources, Triggers & Incentives

Each model hinges on different accelerators, however in all cities extreme weather events have pushed the topic of water sensitivity up the agenda, culminating in Berlin for example in the creation of the Rainwater Agency. Bologna's resilience spending has surged only under state-of-emergency budgets—€2.5 billion for post-2023 flood reconstruction—but the city lacks a steady, proactive funding stream for green infrastructure. Conversely, Bordeaux's mix of national GEMAPI allocations, EU-backed wetland restoration grants and emerging municipal retrofit incentives provides a predictable pipeline for both public and private works. Lower Austria relies on co-funded KLAR! grants and the Water and Wastewater Fund (up to 40 % of planning costs), complemented by targeted pilots like Ober-Grafendorf's Ökostraße; severe floods (2002, 2024) occasionally unlock special aid, but everyday incentives depend on competitive calls.

6. RIPPLES OF INSIGHT

6.a Key Learnings

These four case studies, as differing as they may be, share a series of complementary insights and strengths.

In all four areas there is a fast growing awareness of the issue that are extreme water-related weather events, recognising the **need for a more structured** and **institutionalised approach**. Albeit in different ways, all cases have seen a fast increase in policy-making and project realisation over the past years, highlighting the centrality of this theme for local leaders.

It has also emerged that **individual pioneers**, such as the case for certain municipalities of Lower Austria, can act as **facilitators** and **triggers** into taking leaps forward in the creation of a comprehensive WSC approach.

Integrated planning and continuity **beyond the limit of political cycles** are also essential in facilitating large-scale forward-looking interventions, as the case of Bordeaux demonstrates. Bringing together infrastructure renewal with water management and WSC solutions in an integrated manner is an approach that has proven to be successful.

The importance of **data-collection and monitoring**, as well as research-anchored **coordination bodies**, such as the Rainwater Agency in Berlin is central in fostering stakeholder networks and innovative solutions, whilst also keeping the topic “en vogue” politically and publicly.

Transcending regional boundaries in the sharing of data, thus viewing rivers from a bird’s-eye view, is something that has proven to be fundamental in countries in which regional authorities have competences over river basins, such as is the case for Bologna.

The **involvement of citizens in awareness raising and decision-making processes** has also emerged to be a focal point in the new approach towards WSC. With floods and droughts becoming more common, having a population that is informed about their responsibilities and rights is an emerging priority for many municipalities.

A **hybrid approach** that combines empowered lead agencies, continuous civic engagement, robust data infrastructures and diversified, stable financing offers the most promising path toward resilient, adaptive water governance.

6.b Recommendations

The recommendations proposed in this section are the outcome of the research conducted for this paper. They are proposed to be applied on different governance levels (EU, National, City and Local level), each indicated by a coloured dot.

- EU
- National
- City
- Local

A. Support pioneers across sectors and encourage proactive municipal leadership to unite stakeholders.

Encouraging leadership and visibility has proven transformative across different contexts. The comparison across cities showed that supporting pioneers as individuals or organisations can help to bring the topic in media and in political discussions. Especially promoting flagship projects and rewarding those who developed them, can raise interest and spark discussions that help to mainstream innovative approaches and shape the discourse. Also the recognition of individual and collective leadership should include all levels of governance and sectors contributing to the building of a community of leaders on the topic. For instance, Berlin's Rainwater Days convene diverse stakeholders to discuss critical topics, while the flagship project awards celebrate and promote groundbreaking initiatives, such as innovative green roof projects. Similarly, Bologna's summer water summits exemplify municipal leadership fostering collaboration. In Lower Austria, awards and financial subsidies empower local pioneers, ensuring their efforts receive broader recognition and support.

B. Adopt context-sensitive strategies that prioritize cross-boundary data sharing and collection to address location-specific challenges and opportunities effectively.

Local realities demand tailored approaches and effective data collaboration. Data collection, visibilisation and inclusion in planning processes is key for informed decision making. Especially as public funds are limited. By making data accessible and communicating about potential risks with relevant stakeholders, more awareness can be created, even among those who may be initially reluctant to take action (for example, private owners).
In Berlin, neighborhood dynamics and diverse governance require nuanced solutions, as seen in the Rainwater Agency's coordination roles and GIS-based school flooding risk assessments. Meanwhile, Lower Austria exemplifies transparency by offering homeowners easy access to flood vulnerability data, both online and offline. Bologna's struggles with mismatched regional and state politics underline the importance of harmonizing local and national strategies.

C. Incentivise collaboration beyond administrative borders to create campaigns, interventions, or regulations focused on rivers as geographical entities.

Rivers and water bodies demand governance that transcends administrative borders. Bordeaux's territorial public basin authorities (EPTB) successfully integrate inter-municipal efforts, driving cohesive flood management projects like PAPIs. Similarly, Lower Austria demonstrates how federal grants incentivize municipalities to work together on shared water challenges. Bologna's Italia Sicura project aimed to bridge regional data gaps but highlights the risks of fragmented approaches when dismantled.

D. Promote inclusive decision-making and transparent communication within and outside public administrations to cultivate community involvement and public awareness.

Inclusive governance builds trust and momentum for action. Through participatory processes and responsibilising citizens, awareness of risks can be raised. Because administrations are often compartmentalized, coordinating across departments is crucial both to identify collaborative opportunities for infrastructure projects and to demonstrate how water-sensitive approaches can be beneficial to other urban challenges. Bordeaux's cooperative workshops and citizen reserve initiatives empower communities to engage in water-risk management. In Lower Austria, participatory planning and public access to interactive risk-assessment tools showcase how transparency fosters awareness. Berlin's climate change adaptation managers create monthly meetings between all the different municipal departments to discuss adaptation measures and how they interconnect to create alignment and a shared vision.

E. Combine large-scale interventions and infrastructure projects with water-sensitive solutions, utilizing the momentum.

Strategic integration of infrastructure with water-sensitive designs amplifies outcomes. Renovations of existing housing, streets, parks and other major urban spaces does not occur on a regular basis. Coordination amongst administrations and integrative practices and policies can support the process. E.g. when solar panels are put on roofs, check for the potential of installing a green roof, when tearing up a street to replace pipes, check for the potential of green infrastructure integration. School renovations in Berlin's district of Wilmersdorf Charlottenburg, based on GIS based data analysis exemplify successful multi-stakeholder coordination amongst different administrative departments to renovate schools and adapt them to potential flooding risks. Bologna's tram line project uncovered historical canals, blending transport upgrades with hydrological awareness. Similarly, Bordeaux's dike renovations with compensatory basins and Lower Austria's road-water integration highlight the value of embedding water sensitivity into urban projects.

F. Integrate water-sensitive planning concepts into permitting processes for new infrastructure and housing projects and create incentives for owners of existing housing to adopt water-sensitive interventions.

Permitting processes are key to embedding resilience. They can be a true regulatory tool to incentivise or oblige private actors to integrate water sensitive interventions into their projects. Berlin's BReWa-BE regulation ensures new developments include rainwater retention systems, setting a benchmark for proactive planning. Bologna and Lower Austria stress the importance of targeted funding to retrofit existing housing, ensuring older infrastructure aligns with contemporary water-sensitive practices.

G. Create a "Knowledge Hub" to disseminate best practices across Europe.

Cross-national learning accelerates innovation. Lower Austria's ongoing exchanges with countries like Sweden, alongside international conference participation, exemplify the enthusiasm for shared learning. This highlights the untapped potential for an EU-wide hub to centralize and share expertise, catalyzing water-sensitive practices across Europe.

II. ANNEX

II.a Bristol

Bristol, a city in Gloucestershire, UK, is served by more than 100 miles of waterways[92]. It has a population of from 465,900 people and spans about 110 square kilometres. In 2018 the Bristol City Council declared a climate emergency, as the first city in the UK, due to increasing exposure to heat and extreme weather. Consequently it reorganized its administrative actions laying the groundwork for the One City Ecological Emergency strategy, which commits the city to carbon neutrality and climate resilience by 2030[93] [94].

Over the next 25 years, Bristol's population is expected to grow 535,200 driving demand for the construction of new housing in and around Bristol. As impermeable surfaces expand, Bristol now ranks among the UK's top ten areas for pluvial flood risk, with approximately 22,300 residences already vulnerable[95]. Many of these new homes will be built across fluvial floodplains of the River Avon and in "flash"–flood hotspots where legacy combined-sewer networks compound surface-water flooding and water-quality issues.

Under the national Flood & Water Management Act 2010, Bristol's City Council serves as Lead Local Flood Authority and has translated national mandates into local instruments, including the Local Flood Risk Management Strategy and Local Plan Policies (especially FR1 & FR2). Amongst other things these specifically require a sequential approach to site selection when building new housing. This includes a site-specific floodrisk assessment addressing fluvial, pluvial, groundwater, and sewer-related pathways, finished floor levels above the 1-in-100-year flood level, and safe evacuation routes for residual risk. It also mandates that all new developments demonstrate no net increase in surface-water runoff and to incorporate Sustainable Drainage Systems (SuDS) designed to handle water on site.

Additionally, to manage fluvial flooding, the Bristol Avon Flood Strategy combines riverbank reinforcement and multifunctional greenways. This is funded through blended public, private, and national contributions to protect central Bristol while creating new public amenities such as linear parks[96]. Recognizing that flood-prone wards such as Lawrence Hill also rank among the city's most socially deprived, the local flood strategy aims to prioritize SuDS installations and community engagement in these areas health[97].

II.b Wroclaw

Wrocław, Poland, spans 293 square kilometers with a population of 631,000 and a density of 2,156 inhabitants per square kilometer. With 52.9% of its soil sealed and 37.3% of its area covered by blue and green spaces, the city has faced significant challenges related to flooding and drought. Major floods in the 1990s and 2024 highlighted the vulnerability of the city, which is traversed by the Oder River. To address these challenges, Wrocław has taken a multifaceted approach focused on rainwater management, urban planning, and public engagement[98].

Household Rainwater Management

One key initiative is the **"Catch the Rain"** program, launched in 2019. It provides grants to citizens for installing rainwater harvesting systems, enabling them to reuse rainwater and reduce reliance on tap water. By collecting and using rainwater on-site, residents alleviate pressure on the sewage system and contribute to climate adaptation goals outlined in Wrocław's 2030 Adaptation Plan[99]. Grants covering up to 80% of the costs for creating these rain gardens are available, effectively disconnecting private properties from the municipal drainage system.

Urban Rainwater Management

Since 2017, the city has incorporated sustainable rainwater management into its urban planning. Strategies include on-site reuse and delayed release of retained water to reduce runoff. These principles are embedded in the City Master Plan and local land-use policies. Additionally, the "Catalogue of Good Practices," developed in collaboration with Wrocław University of Environmental and Life Sciences, provides guidance on sustainable rainfall management for road surfaces and built-up areas[100].

Infrastructure and Community Engagement

Through the **Wrocław Water & Wastewater Project II**, the city has invested PLN 959 million (€210 million) in modernizing its water infrastructure (of that €92 million was provided by the European Investment Bank). This includes upgrades to water supply, wastewater treatment, stormwater management, and sludge processing systems to enhance resilience to climate change[101]. Public workshops and school programs, like the upcoming **"I Like the Rain"** initiative, further educate citizens on the value of rainwater as a resource. These combined efforts have improved water management, preserved the natural water cycle, and fostered a stronger connection between Wrocław's residents and their environment, making the city more resilient to both floods and droughts[102].

II.c Eindhoven

With its 230.000 inhabitants Eindhoven is the 5th largest city in the Netherlands and the 2nd largest economy. This European high tech hotspot is built on sandy elevations at the intersection of the Dommel, Gender and Tongelreep rivers. Over the course of the centuries, the rivers have been heavily modified, sometimes being put underground or completely diverted. Current plans envision a restoration of the natural courses of these rivers, bringing them back to life and giving space back to nature.

Eindhoven's climate is humid, with moderate rains as the most common form of precipitation. Over the last decades, the amount and intensity of heavy rainfalls has been increasing, leading to recurrent overflows of the sewers system onto the road network.
85% of the city's sewers are combined, meaning they mix wastewater and rainwater. In case of flooding, water quality is heavily affected, particularly the one of the Dommel river, in which the majority of the flow is discarded[103].

The city has made solving this issue one of its top priorities, including water management in building design and addressing climate mitigation through urban planning. Eindhoven's city council is moving towards a holistic approach to create a water sensitive city, with the objective of making the whole city climate proof[104].

Many measures are currently in place or in project, such as the New Gender Project, aiming to bring the river Gender back to surface and restore its natural path, allowing for decreased risk of overflow as well as better water absorption in the dense, mineral, core of the city[105]. The holistic approach can be seen in the implementation of filtration crates in most of the streets of the city centre, increasing permeability. All of the projects currently in place can be found on Eindhoven Duurzaam, the city's portal dedicated to the creation of a WSC[106].

II.d Malmö

With a population of 317,000 inhabitants, Malmö is the third largest city in Sweden. Located on the seashore and crossed by numerous canals, the city has a continental climate, characterized by cold weather and frequent flooding. Sweden is experiencing increasing levels of precipitation which are projected to rise by up to 40%[107].

In the 1990s, Malmö's public authorities realized that the city's traditional drainage system was no longer functioning efficiently. To address this issue, they developed a Sustainable Urban Drainage System (SUDS)[108]. Today, Malmö is recognized as having one of the most advanced drainage systems in Europe, thanks to its innovative integration of green and blue infrastructure to cope with extreme water events[109].

However, it is worth noting that Malmö also pursued broader objectives. The most flood-prone areas were also the city's most disadvantaged. The municipality took significant action in the 1990s, following decades of neglect in these neighborhoods. Augustenborg, in particular, was severely affected by flooding and had the city's highest unemployment rate and largest immigrant population. In response to strong citizen mobilization, Malmö launched the Augustenborg eco-neighborhood project, which has since been highlighted in academic literature as a best practice. The project also addressed issues such as unemployment, renewable energy, and sustainable transport[110].

Malmö is thus an interesting case study of a city seeking to enhance climate resilience through urban water management while fully involving residents in both planning and implementation.

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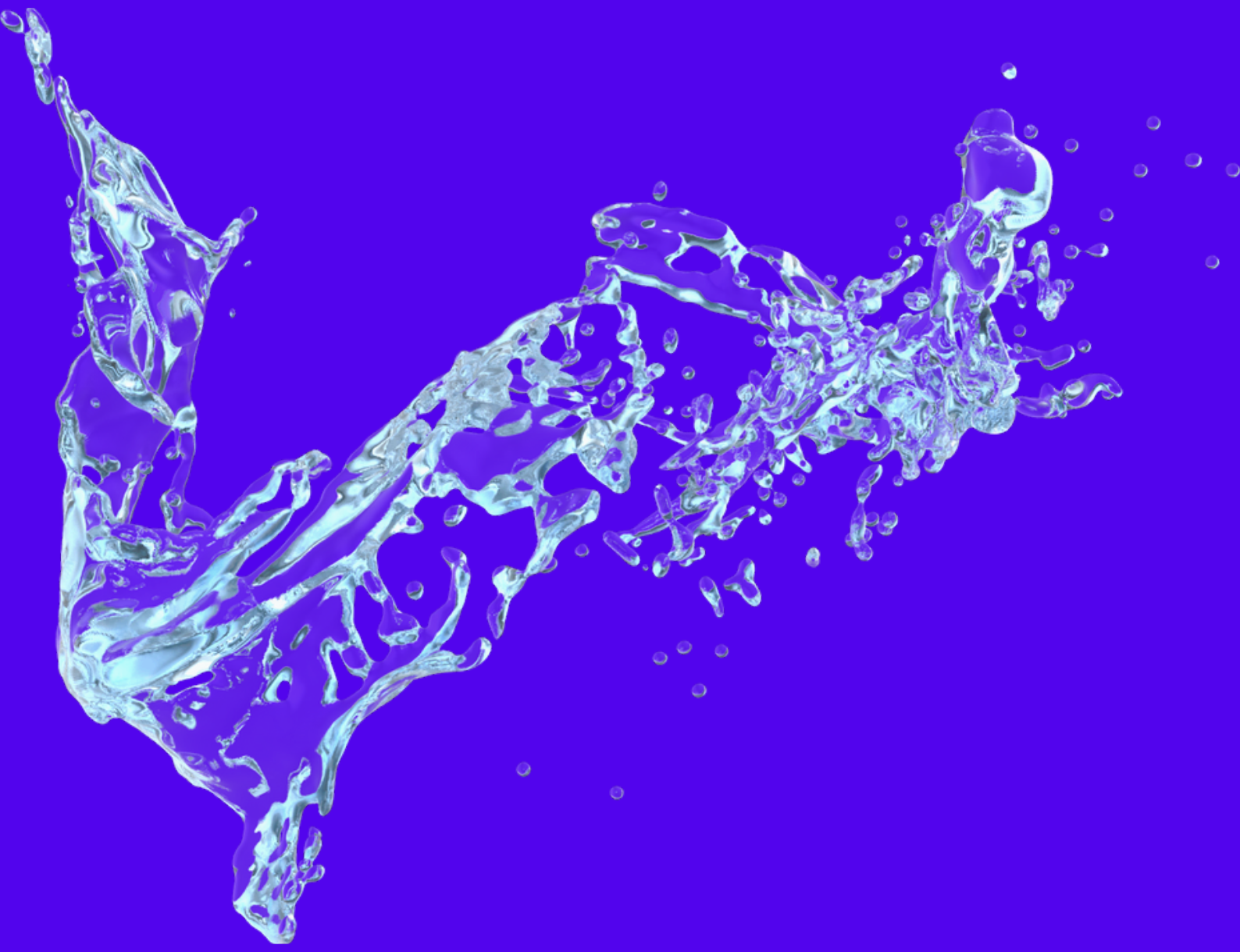

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