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Strengths and Weaknesses for Climate Change: Adaptation in Water Governance: A Comparison Across Six European Regions

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Abstract

This chapter comparatively analyses the policy and governance contexts of six European regions that are affected by different hydrological impacts of climate change. The results demonstrate that a major governance strength across regions lies in the organization of management capacities to deal with existing water-related risks. For example, the Dutch context focuses on water safety, Cyprus has a clear policy framework to deal with water scarcity and in the Norwegian city of Bergen, wastewater is well managed. As a consequence of this focus on present-day risks, climate adaptation governance also focuses on historical risks. New or exacerbated risks posed by climate change remain largely untreated, and responsibilities for dealing with climate-related risks remain unspecified, as also becomes clear in the German and Spanish cases. A high degree of governmental fragmentation is identified as another point of weakness. Identified most clearly in the Portuguese case but recognizable in all regional contexts, different subdomains of water management are dealt with under separate policies and are governed by different responsible agencies. Consequently, information about current performance of the water system is scattered and coordinative efforts, which are key to developing adaptation strategies, are hampered.

Keywords: water governance, climate change, regional impacts, adaptation

1. Introduction: adaptation to climate change in water governance

According to the World Economic Forum's Global Risks Assessment, water problems are among the biggest threats that humanity is facing in the coming century [1]. In the list of the United Nations Office for Disaster Risk Reduction (UNISDR) disaster statistics, floods and droughts rank in the top three of most experienced climate-related disasters between 1980 and 2011. As climate change affects both the quality and the availability of water in the water system, the provision of basic water-related public services such as water safety, drinking water and sanitation is increasingly under pressure [2, 3]. There is widespread agreement on the need to adapt to the hydrological impacts of a changing climate [4, 5].

While the importance of adaptation is widely recognized, developing effective adaptation solutions is challenged by the high uncertainty connected to the process and impacts of climate change. In the adaptation literature, the importance of flexible adaptation solutions that can be adjusted to new insights about the (experienced) effects of climate change is increasingly emphasized. Under the header of "adaptive capacity", scholars have called for adaptation solutions that are flexible, increase social capital and enhance learning [6–10].

In search of adaptive climate adaptation solutions, the emphasis has been placed on governance arrangements. The UNISDR's Global Assessment Report of 2015, for example, emphasizes that dealing with the impacts of climate change require more than a governmental and top-down technical approach [11]. While technical solutions are essential, governance practices that provide the legal, financial and administrative capacities to implement adaptation measures and ensure a sufficient amount of stakeholder participation and public accountability to safeguard the legitimacy of adaptation efforts are equally important. For this reason, the European Water Framework Directive (WFD) also calls on Member States to develop "appropriate administrative arrangements" to effectively deal with the impacts of climate change [12].

In this chapter, we build on the insight that adaptation to climate change requires more than developing new technical solutions in water management. Just as much, it involves finding new governance arrangements that allocate sufficient (financial, technical and administrative) resources to implement effective adaptation solutions. In addition, because water extremes (droughts and floods) typically affect a wide array of stakeholders dependent on a good management of the water cycle, governance arrangements need to be integrative to facilitate links between different sectors and levels of governance to enhance learning, and facilitate a sufficient amount of public participation to ensure legitimacy.

A huge challenge for developing adaptive governance arrangements in the water sector lies in the huge variability of hydrological impacts across regions. This chapter comparatively analyses the regional governance contexts of six European regions differently affected by climate change: the city of Badalona (Spain) and Bergen (Norway) where the risk of flash floods and combined sewer overflow (CSO) increases, the Troodos Mountains (Cyprus) and the Lower Tagus basin (Portugal) where droughts deplete fresh water resources for public water supply and irrigation and the Veluwe (the Netherlands) and the Wupper River Basin (Germany) where integrated water resources management is affected. For each region, the chapter analyses governance strengths and weaknesses for adaptation to the hydrological

impacts of climate change. Based on a comparative analysis, the chapter identifies common as well as regional-specific governance challenges for adaptation to climate change.

The chapter is structured as follows. Section 2 presents the analytical framework used to analyze governance arrangements for climate change adaptation in the water sector. Section 3 describes the findings for each region. Section 4 comparatively analyses these findings, in order to identify common governance challenges in the conclusion (Section 5).

2. Analytical framework

2.1. Adaptive governance arrangements in the water sector

Climate change has huge impacts of the water cycle, but these impacts vary across regions [9, 13, 14]. Whereas in southern Europe climate change may increase the risk of droughts and threaten the availability of water, in other parts of Europe a surplus of water is most problematic and riverine, coastal and storm floods are feared. Similarly, the challenges in urban areas (limited run-off and drainage capacities leading to floods and combined sewage overflows) are usually very different than the challenges rural areas face (decreasing groundwater tables and deteriorating groundwater quality). While the driver behind these risks is similar (climate change), the regional impacts of climate change vary greatly, affecting different parts of the water system and different water-services dependent on that system [2, 15, 16].

At the same time, water governance arrangements differ substantially from region to region. Regional water governance is the product of a long, historical process where arrangements have been influenced by specific geophysical, sociocultural and political circumstances that characterized the regional context throughout history [7, 17]. The adaptive capacity literature emphasizes the importance of an institutional fit between new climate adaptation measures and institutionalized water governance practice for an effective implementation of adaptation measures in regional contexts [18]. The question whether contemporary water governance arrangements can effectively respond to the impacts of climate change, should thus not only take account of the regional variability of climate change impacts, but also of the varying nature of existing regional governance contexts.

This regional diversification surrounding the impacts of climate change on the water cycle and the performances of governance arrangements in dealing with those impacts makes any assessment of adaptive capacity in water governance a challenging task. The adaptive capacity literature therefore displays a strong focus on case studies [19, 20]. And while frameworks have been forwarded to assess or score the adaptive capacity of (water) governance institutions (e.g. [8, 19, 21–25]), these assessment frameworks often remain generalist in scope; they specify general criteria for adaptive capacity but often do not take full account of differences in regional demands and performances.

This chapter uses the three layer framework (TLF) for water governance as a tailor-made analytical tool for analyzing the adaptive capacity of regional water governance arrangements. Rather than formulating criteria, this framework distinguishes between three governance

“layers” in which adaptation to climate change takes shape: a content, an institutional and a relational layer. These layers provide a structure to analyze governance arrangements for adaptation to climate change in the water sector, without specifying criteria for adaptive capacity a priori. The next paragraph introduces this framework in more detail.

2.2. The three layer framework (TLF) for water governance

The three layer framework (TLF) for water governance, designed by Havekes et al. [26], builds on the governance gaps identified by the Organization for Economic Cooperation and Development (OECD) in its 2011 study on water governance in OECD countries [27]. In this report, the OECD argues that water governance increasingly becomes a decentralized policy responsibility in OECD countries. In this decentralized policy landscape, cooperation between different sectors and across different levels becomes more important to adequately deal with the impacts of climate change. However, in its analysis of water governance in 17 OECD countries, analysts found 7 “governance gaps” that hampered a good coordination between governance levels and policy domains.

The TLF takes the OECD governance gaps as a starting point. It forwards a structure to think about closing these governance gaps with the building blocks for good water governance specified by the Dutch Water Governance Centre. These building blocks include a powerful administrative organization in water management, a clear legal framework for water management, an adequate financing system, a systematic (planning) approach and a sufficient participation of stakeholders. In the TLF, these building blocks are placed in three different layers of water governance (see **Figure 1**).

First, the “content” layer looks into the substance of adaptation policies. Through this layer, adaptation policies are characterized by their degree (are relevant climate-related risks addressed in the policy framework, or do certain risks remain untreated?). In addition, the content layer assesses the available expertise and skills needed to develop relevant adaptation policies in a governance context. In this report, this is further specified in terms of



Figure 1. The three layer framework for water governance [26].

information about the regional impacts of climate change and knowledge about possible coping strategies to deal with these regional risks.

Second, the “institutional” layer deals with the organizational aspects that support the effective implementation of designed adaptation policies. In the TLF, good institutional capacities entail clear and legally anchored divisions of responsibility, strong legal and administrative capacities (which, for example, includes workforce, management and supervisory qualities, implementing capacities, monitoring capacities) and a robust financing structure. In this layer, the organization behind adaptation policies is described (e.g., do adaptation policies rely on technical, legal and/or financial policy instruments?).

The third “relational” layer of the framework refers to the requirements placed on the wider governance context of adaptation to climate change. The TLF makes a distinction between culture and ethics, communication and cooperation and participation in this regard. In this report, this is further translated into the extent to which developed adaptation policies establish links between different sectors, the extent to which adaptation governance is clear and open to the public, and the extent to which stakeholder participation is realized in regional governance contexts.

By distinguishing between a content, an institutional and a relational layer, this model helps to better grasp the regional governance challenges posed at the six European research sites: Are challenges mainly related to the content of policy approaches, to institutional arrangements in the water sector or to the relationships and values that underpin water governance? Looking across these regions, this model also contributes to a better understanding of shared governance challenges for adaptation to climate change in the water sector in Europe, as well as of the challenges connected to the governance of certain types of water-related risks.

2.3. Methods

This chapter applies the TLF to analyze the policy and governance context in six European regions: Badalona city in Spain, Bergen city in Norway, nature area the Veluwe in the Netherlands, the Troodos Mountains in Cyprus, the Wupper River Basin in Germany and the lower Tagus basin in Portugal. In each of these regions, climate change poses different risks. Some areas will experience more (storm) floods, in other areas sewage overflow poses a major problem whereas particularly the southern regions face reductions in the quantity and quality of water.

Data for this analysis were collected in two steps. First, questionnaires on policy and governance were sent out to stakeholders; the replies provide information on the policy and governance context at the six BINGO research sites. This allowed to identify site-specific policy and governance needs for adaptation to climate change in different sectors that are impacted by climate change. In **Table 1**, an overview is given of the number of questionnaires collected per research site.

Second, two in-depth expert-interviews were conducted at each research site to generate insights into the national-level policy and governance context that influences regional adaptation. The expert-interviews were held with (1) a key policymaker and (2) a key scientist working on national adaptation policy in the six countries. **Table 2** lists the organizations interviewed at each site.

BINGO research site	Number of questionnaires	Sectors involved
Cyprus/Troodos Mountains region	6	Public administration, public water supply, agriculture, waste water.
Portugal/lower Tagus transboundary river basin	10	Public administration, public water supply, agriculture, waste water, research.
The Netherlands/the Veluwe	6	Public administration, public water supply, water resources management, spatial planning.
Germany/Wupper River Basin	11	Public administration, water resources management, public utilities (water supply and treatment, energy).
Norway/Bergen city	5	Public water supply, research.
Spain/Badalona city	9	Public administration, public water supply, waste water, spatial planning, beach management, research.

Table 1. Questionnaires per research site.

BINGO research site	Expert-interview 1	Expert-interview 2
Cyprus/Troodos Mountains region	Water Development Department	Institute of Environment and Sustainable Development
Portugal/ lower Tagus transboundary river basin (I)	University of Coimbra, Centre for Social Studies (CES)	Tagus River Basin District Administration Division
Portugal/ lower Tagus transboundary river basin (II)	Institute for Water (INAG)	Portuguese Regulatory Authority on Water and Waste Services (ERSAR)
The Netherlands/the Veluwe	Public Administration and Policy department of Wageningen University & Research	Ministry of Infrastructure and the Environment
Germany/Wupper River Basin	North Rhine-Westphalia State Agency for Nature, Environment and Consumer Protection (LANUV)	Wupperverband – Department of Forestry
Norway/Bergen city	Regional Climate & Climate Services and Climate Dynamics departments of Uni Research,	Norwegian Environmental Agency
Spain/Badalona city	Institute of Science and Environmental Technologies (ICTA) of the Autonomous University of Barcelona (AUB)	Spanish Office of Climate Change (OECC) of the Spanish Ministry of Agriculture, Fishing, Food and Environment (MAPAMA)

Table 2. Expert-interviews per research site.

Both the questionnaires and the interview reports were translated by the local project partners in BINGO, and complemented with a first analysis of the meaning of these results in the regional governance contexts. The questionnaires and interviews were further and systematically analyzed in terms of the TLF by the authors of this chapter. The analyses have been sent back to the local project partners for review.

3. Results: governance strengths and weaknesses for adaptation to climate change in six European regions

This section depicts the findings of the analyses of the policy and governance contexts of the six European regions under study for this project. Each subsection starts out with a brief description of the region and the water-related risks brought forward by climate change in the region. This description is followed by an identification of the most important governance strengths and weaknesses for adaptation to the water-related risks. Each subsection ends with a short reflection on the resulting governance needs for effective adaptation to climate change.

3.1. Cyprus, the Troodos Mountains

The Troodos Mountains cover roughly 60% of Cyprus. In the area, most of the island's rivers originate. This research has focused on the downstream area of the Peristerona watershed, which is located on the northern slopes of Troodos Mountains [28]. The three main water uses in the watershed are domestic water supply and irrigation, which rely almost exclusively on groundwater resources [29], and the relatively new sector of wastewater treatment and reuse.

Being a Mediterranean country, water scarcity has posed a persistent risk to Cyprus' water management [30]. The prolongation of dry periods in the future may increase this risk; it may cause groundwater levels to dwindle and existing boreholes to dry out. At present, water availability for domestic water supply just matches the local demand (e.g. in Kato Moni). Besides exacerbating the existing risk of water scarcity, climate change also brings new risks to the region. A deterioration of water quality due to rising temperatures, for instance, poses a new problem. Furthermore, precipitation patterns may change in the near future, with extreme rain events being more likely, which implies higher flooding risks [31, 32].

Governance strengths have been identified in the different layers of the TLF, as regards droughts. Connected to the first layer, water governance in the Peristerona watershed is based on a good understanding of the water system. This is reflected in a strong institutional capacity in the second layer. According to the respondents, regional water governance is guided by a clear and legally embedded policy framework, in which roles and responsibilities for daily management have been defined and divided between different authorities. Furthermore, because key economic sectors, such as agriculture, tourism, environment and energy, depend on continuous water supply, there is strong inter-linkage between these sectors, which supports adaptation in the third layer.

These findings are different for the irrigation subdomain, which operates rather independently from the other policy sectors. Irrigation water supply is managed by local associations of landowners (called "irrigation divisions"), who regulate among themselves the allocation of water resources and share the abstraction costs for irrigation. While administrative and financial resources are less well organized, governance arrangements are characterized by a strong involvement of end-users (land owners), which facilitates the development of tailor-made governance solutions.

Respondents also pointed to a number of weaknesses in water governance. The content of the policy framework is focused on the current situation, and does not sufficiently take into account potential long-term developments such as climate change. At the watershed level, daily management is largely based on empirical knowledge and solutions are based on insights about what works and does not work in practice. As such, adaptation remains focused on existing risks (i.e., frequent droughts) while new risks remain under-addressed. For new or exacerbated risks posed by climate change, it is not specified who is responsible for anticipating the impacts, who is responsible for taking precautionary measures (e.g., who will pay for the infrastructural improvements in the domestic water supply and irrigation networks) and emergency measures (e.g., who is responsible for ensuring the water supply in cases of prolonged drought) and who will carry the burden of potential negative consequences (e.g., higher drinking water prices, crop damages) caused by the impacts. To overcome the potential future risks, and clarify the roles and responsibilities of different actors and end-users in water management, governance arrangements need to be updated and revised.

3.2. Portugal, the lower Tagus transboundary river basin

The research site in Portugal focuses on the lower Tagus transboundary river basin. More than 3 million inhabitants and extensive areas of agriculture are served by its water resources. Water supply, agriculture and hydropower compete for water in a scenario that combines serious riverine and estuarine floods and droughts, and the potential for salt water intrusion from the Tagus estuary.

A governance strength in the lower Tagus transboundary river basin was identified in the Water Law that specifies the roles and responsibilities of different actors at different levels of governance. According to the respondents, roles and responsibilities are clearly defined through this law. For example, water management policies are developed and implemented by the national water authority (the APA) and similar organizations at basin district level.

While water governance in Portugal is backed by a legal framework and delegated to dedicated water agencies, respondents noted a focus on short-term priorities. The existing policy framework is oriented toward pollution control and emergency management, while little structural solutions are developed to deal with long-term quantity and quality decreases. Because of this, critical questions regarding the sustainable, balanced and equitable use of water in the future are not addressed. This concern was reinforced by the trend to outsourcing routine activities, which results in a high dependency on other (mainly academic) entities and limits the national administration's analysis skills.

In addition, the top-down character of water management in Portugal was seen to discourage stakeholders and end-users involvement. Citizens are often only involved in a late stage of the decision-making process, with short time to do so. Moreover, public consultation is generally directed to civil society and not targeted to specific sectors or stakeholders. As a result, awareness of the importance of climate change adaptation is not widespread among different water users and stakeholders.

Respondents also identified a gap between adaptation planning at the national level and the implementation of adaptation solutions in the region. While intersectoral linkages are made

at the national level, these links are lost in the translation of national-level objectives to sectoral water management plans at the regional level. This is problematic because sectors can provide constraints for the development of regional water management plans. For instance, improvements in irrigation are constrained by nature policy. Environmental and economic licensing procedures are sometimes conflicting and not well articulated. Links between sectors are very important in overcoming these constraints.

Without an intersectoral approach to climate change adaptation, different sectors have developed their own strategies to climate change adaptation. In the public water supply sector, the Regulatory Authority on Water and Waste Services (ERSAR) offers a number of effective policy instruments, including laws, strategic plans, financial arrangements, knowledge development and public awareness raising campaigns. The public water supply company (EPAL) has independently developed a risk management approach and implemented a set of technical measures to deal with the risk of decreased water quality and quantity.

Adaptation to climate change in the agricultural sector is more complex. Currently, there are public as well as private irrigation schemes, which results in a diversity of water management approaches. Consequently, this sector shows different levels and approaches to climate change adaptation. Despite these differences, respondents note that in general, the agriculture sector has made significant improvements in the products, techniques and technologies used to increase water use efficiency, combat the negative effects of fertilization and control plagues.

To improve adaptation governance in the lower Tagus transboundary river basin, several aspects can be reinforced. Most importantly, national water legislation in Portugal could benefit from simplification and harmonization. There is a good legal framework but there is a need to develop policies, strategies, means and mechanisms to implement measures at the regional level. While especially through sectoral initiatives, water management in Portugal is characterized by a good scientific and technical knowledge base, respondents in particular referred to the absence of a comprehensive policy for water use (in addition to resources management) to balance the claims of different stakeholders on the water resource in lower Tagus transboundary river basin.

3.3. The Netherlands, the Veluwe

The Veluwe is a forest-rich ridge of hills (1250 km²) in the province of Gelderland in the Netherlands. The Veluwe features many different landscapes, including woodland, heath, some small lakes and Europe's largest sand drifts. Water abstractions provide ca. 2 million people with drinking water and further services industries, agriculture and nature.

The water system is vulnerable to droughts, which previously have led to a ban on overhead irrigation, a deterioration of water quality and insufficient good quality water for humans, nature and agriculture. Increasing droughts will have an effect on vegetation and soil composition, which will in turn influence groundwater replenishments. These effects are not accounted for in current models.

The Netherlands has a strong tradition in water policy. Emerged as a decentralized responsibility, with regional water boards being the oldest democratic institutions in the Netherlands, water management is now a top national priority. Water policy is well institutionalized, with

a clear division of responsibilities among different governmental organizations, not only at the national but also at the regional level. The level of knowledge about water systems in general is high, and the Netherlands is leading in water research. Water policy is transparent, with sufficient information available to stakeholders and the public.

There are three main concerns with regard to climate change adaptation at the Veluwe region. Firstly, there is insufficient knowledge about the impact of climate change at the Veluwe and how it will affect stakeholders.

As a consequence, secondly, climate change adaptation is overall not at the forefront of the debate. A National Adaptation Strategy was recently passed by the Dutch parliament but this strategy is not as powerful as the Second Delta Program that specifically deals with water management, as it lacks legislative and regulatory instruments. Despite the encouragement in the EU Climate Adaptation Strategy to develop a holistic vision to adaptation, such a vision is lacking in the Netherlands, which was also noted in an audit by the General Audit Chamber of The Netherlands. Because of this, it is difficult to convince stakeholders of the urgency of climate change adaptation. This makes coordinated efforts difficult, because stakeholders do not see the need disregard their own interest in favor of climate change adaptation.

Thirdly, water policy is, in practice, not very well integrated with other policy fields. Respondents indicate that a vision on the whole water system is lacking. The lacking integration of water policy with spatial planning is also reason for concern. This separation is strongest at the national level. There used to be a coordinated spatial planning in the Netherlands, but that is now more or less abandoned and left to lower levels of government. Instead of a long-term vision for the whole of the country, a more locally oriented problem solving approach is now dominant.

To improve the current situation, climate change research in the Netherlands should be expanded from water management to other sectors such as health care, ICT, and transport to obtain a broader risk assessment. At the national level, this is challenging, since government departments are highly specialized and often have opposing views and interests. At the regional and local level, this should be easier, because the effects of climate change become more tangible. Research such as the BINGO-project could lead to more knowledge and awareness of the impact of climate change at the Veluwe. These impacts can then be addressed as a shared challenge for the stakeholders and allow for more cooperation and coordination. This should be done based on a shared vision of the Veluwe in which different policy areas are integrated. Adaptation should not be incidental, but integrated into the regular operations in the area.

3.4. Germany, the Wupper River basin

The Wupper River Basin is located in the state of North-Rhine Westphalia, Germany, with an area of 813 km² and a population of approximately 950,000 inhabitants. The Wupper is an upland river with a length of about 115 km, rising in Marienheide-Börlinghausen (Oberbergischer Kreis district) and flowing into the Rhine River at the city of Leverkusen. The Wupper River and its many tributaries form a river network of ca. 2300 km. The Große Dhünn Reservoir – the second largest drinking water reservoir in Germany – is located within the Dhünn River catchment area, one of the main tributaries of the Wupper River.

The Wupper Association is responsible for water management of all water bodies within the Wupper River Basin. As a public body, the Wupper Association performs its tasks in the public interest and for the benefit of its association members: town councils, local and district authorities, municipal water suppliers, and effluent disposal businesses, trade and industrial organizations in the catchment area of the Wupper River. Their contributions cover the costs of wastewater treatment with sewage sludge disposal, flood protection, managing water flow during dry periods (raising low water levels), water supply provision and maintenance and ecological development of rivers and streams. Close cooperation allows also for the identification of water management strategies. The Wupper Association operates 12 reservoirs, 11 wastewater treatment plants, numerous storm water tanks and flood control reservoirs.

The confidence among the stakeholders to work together on climate change issues stands out as a strong suit for the Wupper region. This is in part because the personal relations and communications are well developed. Water policy in is well integrated with other policy fields, whereas land use planning is mentioned as a successful example. Also, the respondents feel that a wide range of tools is available to tackle current climate risks, such as floods. The professionals who deal with these issues have the right knowledge, skills and training to do so. In addition, the publication of official flood maps is thought to have actually reduced the stress on affected areas. Transparency is considered another strength. Stakeholders are informed about the regular conferences that are organized on water management and feel up to date about new problems and developments in this field.

However, the Wupper region lacks a comprehensive, coordinated strategy to deal with future climate change. Some respondents mention the lack of a general strategy on climate change adaptation, others mention the lack of information exchange among stakeholders with regard to climate change adaptation, though personal relations and communication are well developed. For instance, building owners are insufficiently informed about their risks. This might be caused by a lack of knowledge about future climate change effects on the Wupper Basin whereas respondents point out that more reliable predictions of extreme weather events are missing. This also makes it hard to work on climate adaptation. Finally, the duration (2–5 years) and bureaucratic nature of the planning process is mentioned as a weakness.

The Wupper catchment area would benefit from a systematic inclusion of climate change adaptation in all layers of governance. For the content layer this means developing a general, coordinated strategy on climate change adaptation. This requires more specific knowledge about the future state of the climate in the Wupper Basin and the effects that it has on the different stakeholders (institutional layer). This knowledge then has to be implemented in mandatory guidelines (for instance, for urban planning) and clear strategic goals, including responsibilities, action plans and time lines. Also, respondents suggest to introduce a financing scheme (through fees) specifically to finance climate adaptation.

For the relational layer, the primary improvement would be the coordination of climate change adaptation among different stakeholders and different levels of government. This could be done by expanding the integrated planning approach for climate change adaptation, create better networks and comprehensively institutionalize the collaboration on climate change adaptation. One suggestion is to appoint a climate change officer to coordinate climate change-related activities among the stakeholders.

3.5. Norway, Bergen city

Bergen is Norway's second largest city with 270,000 inhabitants. The city is located on the shadow of the mountain Løvstakken. Currently, the lower lying parts of the city, close to the sea, are going through a big transition where industrial areas are replaced by residential areas.

Known for its rainy climate, heavy precipitation loads pose a major threat to Bergen city. With a closed water system, the city is at risk of flash floods. In addition, because the sewer and stormwater system are not fully separated, there is a risk of CSO. The discharge of CSO's into the subjacent fjord Puddefjorden may cause risks to the health of people living close to the fjord and the environment that surrounds it. These risks can be exacerbated by more extreme weather conditions and sea level rise.

Key strengths of the Bergen governance context for adaptation lie first of all in the content layer of water governance. Information on water-related risks is well organized and much effort has been put in disseminating this information to local governance levels where the main responsibilities for water management are allocated. Second, in the institutional layer, responsibilities for water management are well-arranged, with general guidelines specified at the national level to ensure a basic quality, which can be tailored to local-level characteristics and needs by county and municipal governments. Third, in the relational layer of water governance, strong links have been created between water management and spatial planning.

Key weaknesses of the Bergen policy and governance context are threefold. First, the information on weather-related risks is based on historical data recordings. Less is known about the future conditions, and the threats these conditions pose on (the different regions in) Norway. Second, information that is available is not translated in the existing policy framework on water management. While information on climate-related impacts is increasingly collected and analyzed, this information is not linked to binding actions in official policy documents and laws on water management in Norway. Up to now, climate change adaptation is merely incorporated in strategic plans at all levels (white papers, master plans), but actual responsibilities for adapting to the impacts have not been assigned. Consequently, third, the actual implementation of adaptation solutions is difficult to realize. There is huge regional variation in adaptation governance throughout Norway and because of a lack of enforced implementation, the necessary links between water management and other sectors that are affected by climate change are not made. Because of this, opportunities to develop and implement effective integral solutions for climate change adaptation are currently missed.

In summary, there are three main governance needs (which are linked) to improve the organization of climate change adaptation in Bergen's policy and governance context. First, there is a need for better risk and vulnerability assessments that provide insight into the future risks climate change poses to the water system in Bergen. Second, adaptation policies need to be included in the policy framework on water management, especially for stormwater. While responsibilities for water management are decentralized in Norway, respondents identify a need to take on some responsibility for adaptation at the national level. At the national level, the Norwegian Water Resources and Energy Directorate could include adaptation governance in its guidelines for water management. Also, information about the impacts of climate change could be provided on a less voluntary basis, for example, by requiring communities to

take appropriate adaptation measures based on the information they receive. To support such actions, Norway could greatly profit from its decentralized responsibility structure in water governance, where management guidelines are formulated at the national level to ensure equal starting conditions but which can be adapted to local conditions to support the development of effective regional solutions. At the level of Bergen city, respondents recommend to develop a strategic stormwater plan and include it in the municipal master plan.

3.6. Spain, Badalona city

Badalona city is located along Spain's north-eastern coast. It belongs to the province of Barcelona, which lies in the region of Catalonia. Over the years, as the city of Barcelona extended its space claim, this megacity has grown onto Badalona and now it is part of the Barcelona Metropolitan Area. Badalona lies directly adjacent to the Mediterranean Sea, it is bordered by the Besos River in the west and surrounded by the steep Serra de la Marina Mountains in the northeast. The city covers over 21 square km with an altitude difference of almost 500 m running from the mainland down to the sea. It is one of the most densely populated cities in Catalonia with 220,000 inhabitants. Its almost 5 km of Mediterranean beaches offer a popular tourist destination. Together with income from commerce and shipping at the harbor, tourism is an important economic driver of the city.

Characterized by steep differences in altitude (high slopes in the upper parts and flat areas in the lower parts), Badalona is vulnerable to problems with drainage. Urban flash floods and combined sewage overflows (CSO's) already resulted in more than 125 million euros of claimed insurance damage in 1999 and present a major threat to water quality and tourism. Being a sea-front city makes Badalona also susceptible to coastal flooding. In 2000, 80 million euros was claimed after a coastal flood. At the same time, the city faces risks related to periods of drought. Its water resources are limited and drought not only challenges the supply of water (scarcity) but also the quality of the water sources. Climate change may increase all these risks in Badalona city.

One of the major strengths of the Badalona governance context is its strong and well-defined policy framework for water management. The policy framework covers all relevant aspects of water management. In each of these subdomains, existing problems are well known and the context is well understood. Policies therefore outline appropriate tasks to deal with these problems. Most respondents also feel that this policy framework is backed by a strong legal and administrative planning structure, with well-defined responsibilities for current water management tasks. In addition, technical knowledge about the current water system is also available to responsible parties. In Badalona, actors are aware of their responsibilities in water management but not always have the resources (financial and technical) to act on this.

A major point of weakness in the Badalona governance context lies in its fragmented structure and incomplete funding, especially for urban drainage system. Responsibilities are clearly defined and assigned, but they are fragmented over different governance levels and actors and there is little oversight or monitoring on the sector as a whole. Because of this, some critical linkages between different subsectors of water management (e.g. sewer and beach management) are currently not made. Furthermore, existing water management practices are underpinned by an incomplete financial structure, because it lacks a municipal sewerage tax and also because financial contributions to water sanitation have been sharply reduced in recent years.

A second major weakness is the focus of current water management practices on the existing situation. There is no structural consideration of the potential future changes and risks instigated by climate change in the governance context. This implies that no responsibilities and resources (financial, administrative and knowledge) are assigned to deal with these future risks, but also that if something goes wrong, no one can be held responsible and parties look at each other to provide a solution.

Both weaknesses may actually reinforce each other. While climate change is a structural factor in national-level policy documents such as the National Hydrological Plan and the National Adaptation Plan, as well as in national-level initiatives such as the set-up of the OECC, these exertions do not easily trickle down to the regional and local level, where governmental fragmentation hinders cross-sectoral collaboration. With little monitoring and oversight, parties will continue to only operate within their limited set of responsibilities and risks that impact on the system as a whole will not be anticipated.

Three governance needs can be identified. First, there is a need for more knowledge about the impacts of climate change on the different subsectors of water management in Badalona and the water system as a whole. This would help to increase awareness about the possible detrimental effects on the water system and help to better anticipate these effects by developing new adaptation policies. Second, there is a need for more coordination in Badalona's water management. This coordination would not only help to create better links between the different subsectors of water management at different levels of governance (city, metropolitan and regional level), but also to establish important links between the water sector and other sectors, such as spatial planning. Third, there is a need for a new governance style that is anticipatory rather than reactive and for policy measures that target long-term developments rather than the existing situation. Increased awareness and better coordination could be the first steps to realize this change, together with the suitable funding framework that nowadays is not enough to cover all the necessities arising from the water cycle management, especially to those related to the urban drainage system.

4. Comparative analysis

What stands out from the analysis is that overall, existing water management practices are well organized at the different research sites. This becomes visible in all layers of the framework for water governance.

In the content layer, the policy and governance arrangements fit the specific contexts of the six BINGO research sites. The frameworks generally cover relevant aspects of water management at these sites (e.g., flood risks, water quality, waste water and beach management). With the exception of some specific subdomains, actors generally feel that existing policies address the most important contemporary issues in water management. In addition, relevant information is collected to support water management in these different subdomains. Responsible actors have access to the information they need to perform their daily management tasks.

Regional policy frameworks for water management are usually backed by strong institutional arrangements. For the different subsectors of water management, tasks and responsibilities have been clearly outlined and allocated to different actors, at least formally. Overall, administrative resources are also well organized and tailored to these tasks. There is sufficient capacity to implement water management policies, there is sufficient monitoring capacity (e.g., on the price and quality of drinking water), Portugal being the only case where there is substantial concern about monitoring, and in most cases, water management is supported by an adequate financial structure that ensures a long-term and stable source of funding for existing water management practices, but not necessarily climate change adaptation.

Because responsibilities for existing climate risks are well-defined and allocated, water management at the research sites is generally transparent and open to public inquiry. The existing organizations of water management therefore provide for a necessary amount of public accountability. Also, particularly in Germany and in Norway, links between water management and spatial planning are being developed.

It should be noted that for the subdomains of irrigation and groundwater management, policy frameworks seem to be less well organized. In these subdomains, responsibilities are often unclear and sometimes overlap, and a good financial structure is not guaranteed. These subdomains tend to be characterized by a high degree of self-organization, which, on the positive side, has positive effects on the degree of stakeholder participation in these domains.

In addition to these governance strengths for adaptation to climate-related water risks across the six European regions under study, general governance weaknesses can also be identified.

What stood out first from the analysis is that the policy contexts at the research sites insufficiently take future climate risks into account. Existing policies display a clear focus on contemporary challenges in water management. For example, droughts have always been a major problem in Cyprus, thus there are strong policies to deal with water shortages on the island. In the Dutch lowlands, floods and water quantity management have always been the highest priority. Because of this strong focus on present-day challenges, the future risks posed by climate change are insufficiently incorporated in existing policy frameworks. In Bergen city, for example, risks related to storm water are not yet addressed in the municipal policy framework. One of the causes underlying the strong focus on contemporary problems in regional water management connects to a lack of information about the regional impacts of climate change. While different actors are aware of climate change in general, the impacts are only understood on a global level and there is little data on how climate change affects different aspects of the water system in different localities.

As a consequence of the present-day focus in regional water management, climate adaptation policies in the BINGO regions tend to target historical risks. For example, in Cyprus climate change is mostly linked to increasing water scarcity and as a result, existing policies in this field are strengthened to deal with this increased risk. In the Netherlands, climate change adaptation is incorporated under the header of water management, while climate-related water quality and health risks remain untreated. At the same time, it should be noted that these adaptation policies remain highly strategic; the importance of adaptation is particularly

emphasized in strategic visions and policy lines at higher levels of governance, but the translation of these visions in actual adaptation policies is difficult in all regions. Because adaptation policies are mainly formulated at a strategic level, clear adaptation targets have not been specified, responsibilities have not been defined, and structural financial resources have not been allocated to address new risks of climate change adaptation.

Another governance weakness is the high degree of fragmentation that characterizes existing water management practices in the regional governance contexts. At the six research sites, different subdomains of water management are governed by different actors and through a different subset of policies. In Cyprus, Spain and Portugal, drinking water, irrigation, waste water and flood risk management are, for example, dealt with under separate policies and by different responsible agencies. Because of this, information about the water system and its current performances is also scattered across different subdomains of water management. This hampers the coordinative capacities of the management system.

A related weakness lies in the lack of collaboration, not only between the different subdomains of water management but also between water management and other sectors such as spatial planning, environmental management, agriculture and tourism. In some regional governance contexts, links with other sectors (mainly spatial planning) have been established, but in general, linkages could be improved. Also, a lack of stakeholder participation was identified. While the structural integration of stakeholder participation varies across regional governance contexts, overall, but problems were experienced with the involvement of new types of stakeholders in water management, such as end-users or the private sector. It is difficult to organize participation of these new stakeholders because they are often not fully aware of the impacts of climate change on their own operations, and because they often have conflicting interests.

5. Conclusion: common governance challenges for adaptation to climate change in Europe

Assessing governance strengths and weaknesses in for climate change adaptation in six European research sites, three main governance challenges can be identified.

First, a common challenge seems to lie in incorporating new climate change risks in the existing policy and governance framework, and in developing and implementing adaptation measures to deal with these new risks. The specific nature of this challenge varies across research sites. In Badalona, the policy framework is strongly oriented toward the existing problems of droughts, water scarcity and floods but the risk of CSO's is insufficiently recognized. And in Bergen, drinking water and wastewater are well managed, but no policies have been developed to deal with the increased risks posed by storm water. However, the general characteristics of this governance challenge are similar.

This challenge can be addressed by establishing a more anticipatory governance setting, which is able to look beyond contemporary problems in water management to the new risks posed by climate change. To facilitate this change, more information about the specific impacts of climate change at the regional level is needed, which should be disseminated to actors and agencies that are responsible for or work within the water system.

Second, there is a need for a more holistic governance approach. Climate change not only affects water management but a whole range of sectors and actors. Therefore, stakeholders from different sectors need to be involved in the formulation of adaptation solutions. Also, better links should be established between the different subsectors of water management (e.g., storm water and waste water in Bergen, or beach management and water quality management in Badalona) to effectively deal with climate change risks. To establish a more holistic approach, the governmental fragmentation that currently characterizes regional water management should be reduced and regional coordination should be improved to enlarge integrative capacities of water governance.

Third, the effective implementation of adaptation measures should be strengthened. To this end, institutional resources need to be organized for climate change adaptation. Policies should define adaptation targets for the treatment of different risks, and allocate responsibilities and administrative and financial resources accordingly.

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