KAPITEL 9 / *CHAPTER 9* [9]
MUNICIPAL STRATEGIES AND CURRENT GOVERNANCE TRENDS FOR SUSTAINABLE STORMWATER MANAGEMENT IN EXISTING SETTLEMENTS IN GERMANY

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Introduction

In Germany, as in many other countries, urban water infrastructure systems face evolving conditions and demands, driven by factors such as climate change, demographic shifts, and the increasing need for ecological sustainability in water management. To address these challenges, it is often deemed essential to transform infrastructure systems through not only extensive technical innovations but also significant organizational and institutional changes in service provision [1].

A crucial aspect of urban water systems is stormwater management. For the past century, Germany's municipal stormwater management has relied heavily on the public drainage system, managed by public authorities on and beneath public land. However, the effectiveness of this system has been increasingly questioned over recent decades due to numerous challenges. Climate change, for example, is expected to heighten the frequency of heavy rain events, leading to more frequent urban flash floods and increased pollution of rivers receiving this excess water. Consequently, meeting traditional stormwater management objectives—such as flood protection and surface water protection—while also complying with more stringent environmental standards, such as those outlined by the EU Water Framework Directive (WFD), has become more challenging [2].

The importance of stormwater management is further underscored by the need to restore a more natural water balance in urban areas and mitigate heat stress, such as through the positive climate effects of green roofs. Decentralized stormwater management options are gaining prominence as effective strategies to achieve these objectives. These options include local measures like water retention, decoupling sealed surfaces from the mains drainage system, and enhancing water infiltration,

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evapotranspiration, and rainwater use. Incorporating these components into the existing centralized system can yield several benefits, including the protection of water resources, reduction of emissions by lowering peak flows, and bringing urban water balance closer to its natural state through increased infiltration and evapotranspiration [3].

Despite these benefits, similar services can also be achieved — at least partially — by modifying centralized systems, such as increasing retention capacity or creating centralized infiltration ponds. From a cost-effectiveness perspective, however, decentralization options may be more advantageous, as they avoid the high costs associated with adapting centralized drainage systems. Additionally, decentralization offers greater flexibility within the overall system, particularly considering the uncertainties posed by climate change.

Nonetheless, there are compelling reasons both for and against decentralization. While decentralization can provide increased system flexibility, it may also lead to the devaluation of previous investments, higher costs (and thus charges), loss of economies of scale, and increased transaction costs. Balancing these considerations is crucial for making informed decisions about the future of stormwater management infrastructure.

The terms "decentralized" and "sustainable" are not synonymous. Here, "sustainable" is understood as achieving the most optimal and long-term balance between the ecological, economic, and social issues associated with infrastructure development. The sustainability challenge municipalities face is to find a new balance between centralization and decentralization based on local requirements, which can vary significantly in terms of natural landscape conditions, settlement structures, and the state of local infrastructure.

A critical issue in this rebalancing process is the extent to which property owners should be tasked with installing and operating decentralized options, given the significant portion of urban area that is privately owned. Traditionally, property owners have been merely customers of drainage services, while municipalities have been the providers. Overcoming this conventional understanding of roles presents a particular challenge for municipal governance. Engaging a large stakeholder group in planning

and implementation adds complexity to decision-making processes due to the legal, technical, and socioeconomic issues involved. To circumvent these problems, municipalities could build and operate decentralized options on public land, thus reaping the benefits of decentralization without the complications of dealing with private landowners [4, 5, 6].

This is the starting point for the present analysis, which investigates the current direction of stormwater management in German municipalities and explores whether and how property owners are becoming involved. Building on numerous studies that have laid the groundwork for designing sustainable stormwater management from a technical perspective, this study focuses on the institutional aspects of municipal stormwater governance in Germany and their strategic contribution toward integrating property owners. According to the New Institutional Economics theory, institutions are defined as a set of formal and informal rules that guide human interaction by defining and limiting actors' decision space. These institutions play a significant role in steering transformation processes [7].

Focusing on two fundamental municipal institutions for regulating stormwater management—compulsory connection and usage, and stormwater charges—this study addresses the following questions: How do these key institutions link the varied objectives of stormwater management with the decentralization options available to property owners? Which institutional designs can effectively integrate property owners into municipal stormwater strategies? What are the current local government practices?

There are numerous other institutions governing stormwater management in urban areas, such as urban land-use planning, local statutes mandating the use of green roofs, local funding programs for decentralization measures, information campaigns, and restrictions on the use of centralized systems. However, this study focuses on compulsory connection and usage and stormwater charges because these institutions are ubiquitous in municipalities and impact the entire city, forming the institutional foundation for stormwater management. By analyzing the design of institutions and their interactions, it is possible to identify current trends in the transformation of stormwater management systems more quickly than by monitoring changes to

technical systems, which generally occur more slowly [8,9].

To explore these questions, the article is organized as follows: First, an analytical framework is developed to derive coherent institutional designs for the two key institutions. This framework enables an analysis of the effects of institutional interplay on property owners' decisions and establishes links between institutional design options, municipal stormwater management objectives, and strategies to integrate property owners. These coherent institutional designs provide a basis for empirically assessing the current practices of 44 selected large German cities.

Empirical data were collected at the municipal level in 2019 and compared with a previous assessment from 2012. The empirical results are discussed against the backdrop of theoretical considerations, providing insights into the evolving landscape of stormwater management in German municipalities [10, 11, 12].

9.1. Involving Property Owners in Municipal Stormwater Management

In a municipality, institutions play a crucial role in aligning the actions of property owners with the objectives of municipal stakeholders regarding stormwater management. Institutions establish decision-making power (who decides?), permissible alternatives (what can be decided on?), and the decision-making process itself (how will it be decided?). Additionally, institutions can indirectly influence behavior by setting incentives that promote certain technologies. For complex tasks such as stormwater management, it is necessary to utilize a range of institutions to coordinate various measures. This analysis focuses on two key institutions: compulsory connection and usage, and stormwater charges. Ideally, the effects of these institutions should complement each other. To ensure this, the institutional settings should be designed by the municipality through two strategic planning steps. First, the municipality must decide on the set of stormwater management objectives it seeks to implement, weighting the objectives according to local conditions and development needs. Second, the municipality must determine whether private property owners are

to play an active role in stormwater management and, if so, which objectives they should support.

Detailed analysis of the process illustrates these two strategic planning steps preceding the design of institutions. It also shows how institutions operate and the conditions necessary for their effective integration. Institutions should interact in such a way that (i) by granting or refusing decision-making power, (ii) by approving or discounting options, and (iii) by setting incentives, property owners' investment decisions are harmonized with the municipality's strategic plans [13, 14, 15, 16].

This section summarizes the objectives of stormwater management before introducing the options and assessing their ability to meet these objectives. Four general strategies for integrating property owners into stormwater management are identified. The institutions in question are then described, and four coherent institutional designs are specified. It is argued that while coherent institutional designs can be distinguished from non-coherent ones, it makes no sense to rank the coherent designs themselves. This is because the municipality's preferred system and strategies for integrating property owners are geared toward local conditions and may vary significantly. However, the institutional design selected by municipalities can be observed, making it possible to draw conclusions about the system to be implemented and the strategy for integrating property owners.

Sets of Municipal Stormwater Management Objectives for a municipality to develop a sustainable stormwater management infrastructure, it needs to decide on a specific set of objectives, some of which may conflict with each other. The main objectives of stormwater management include:

- Flood Protection: Preventing urban flash floods caused by heavy rain events.
- Surface Water Protection: Reducing pollution in rivers and streams.
- Ecological Sustainability: Meeting environmental requirements such as those stipulated by the EU Water Framework Directive (WFD).
- Climate Adaptation: Addressing heat stress and improving the water balance in urban areas.

The specific combination of institutional settings is referred to as institutional design. An institutional design is described as coherent if the technical design of private stormwater management aligns with the municipality's preferred system and strategic plans for involving private property owners. For example, institutional design depends on the available options for stormwater management: if no decentralized option can meet a certain objective, integrating property owners is unnecessary. Institutional frameworks should enable municipalities to design institutions that successfully integrate property owners into stormwater management.

In the following sections, we summarize the objectives of stormwater management, introduce the available options, and reflect on their ability to meet these objectives. We then identify four general strategies for integrating property owners into stormwater management and describe the relevant institutions, specifying four coherent institutional designs. While coherent institutional designs can be distinguished from non-coherent ones, ranking them is unnecessary because the municipality's preferred system and integration strategies vary based on local conditions and may not be uniformly reported by municipalities. Nonetheless, observing the institutional design selected by municipalities allows conclusions to be drawn regarding the system to be implemented and the accompanying strategy for integrating property owners.

9.2. Institutions for Integrating Property Owners

As previously noted, the key institutions in stormwater governance in Germany are (i) municipal provisions regarding compulsory connection and usage and (ii) stormwater charges [15, 16, 17].

(i) Municipal Provisions on Compulsory Connection and Usage: These provisions establish the decision-making authority of property owners in selecting local stormwater technologies, directly impacting the extent of decentralization possible. Under compulsory connection and usage rules, property owners must connect

their properties to the public sewage system and discharge into it. This requirement is enforced rigorously for wastewater disposal by municipalities. However, for stormwater, the enforcement is less strict, provided that it does not compromise public interests such as environmental compatibility or the functionality and economic viability of traditional sewage systems. Although strict enforcement of these provisions limits property owners' choices and significantly reduces the likelihood of decentralization, it does not entirely preclude the use of decentralized stormwater management options, as not all practical options are covered by these regulations.

(ii) Stormwater Charges: The costs associated with urban drainage systems are recovered through levying charges on property owners. Following the compulsory introduction of new stormwater charges in Germany, stormwater drainage and wastewater are now paid for separately by property owners through a "split wastewater charge." The wastewater charge is based on the volume of drinking water consumed (euros per m^3), whereas the stormwater drainage charge depends on the size of the drainage area connected to the mains system (euros per m^2), aligning with the polluter pays principle [8].

Beyond financing, these charges also serve a regulatory function. The implementation of stormwater charges incentivizes property owners to reduce the size of connected drainage areas and the volume of stormwater runoff. The charge level itself encourages decoupling of drainage areas through methods like unsealing and infiltration, though it may not promote local measures that do not change the drainage area size, such as green roofs or cisterns. To systematically encourage or discourage these latter technologies, special rebates on stormwater charges are necessary. This is achieved by offering rebates for the use of specific local measures and setting appropriate rebate levels (e.g., for installing green roofs, cisterns, or infiltration systems). Thus, the design of stormwater charges allows municipal authorities to influence property owners' behavior towards decentralization [14].

9.3. Empirical Study

In the empirical section below, we investigate whether the four institutional designs identified as coherent for integrating property owners are implemented in practice. We also aim to discover which designs are preferred by municipalities and the direction in which stormwater systems are being developed. To address these questions, we evaluated the institutional framework conditions of 44 selected cities in Germany using the previously presented analytical framework. This involved analyzing current local municipal statutes regarding drainage regulation (Abwassersatzung) and wastewater charges (Abwassergebührensatzung), focusing on local characteristics of "compulsory connection and usage" and "stormwater charges." Municipal statutes are legally binding rules that detail local arrangements. Although differences exist due to varying state laws and city council practices, the overall structure of municipal statutes is generally consistent. The authors' interpretations of the relevant paragraphs were validated by legal experts [4, 9, 15]. Additionally, we evaluated informational materials provided by the cities about stormwater management options on private properties. The cities were systematically selected based on a ranking of charge levels, with special consideration given to those with the highest and lowest charges. To ensure regional diversity, cities from federal states not initially included were added to the sample. Our empirical analysis reveals significant differences among German municipalities in the specific design of institutional settings. The results are presented below.

Compulsory Connection and Usage. Three types of compulsory connection and usage were identified in municipal statutes:

1. ***Type 1:*** No compulsory connection and usage.
2. ***Type 2:*** Compulsory connection and usage with the possibility of exemptions.
3. ***Type 3:*** Compulsory connection and usage without exemptions.

In more than half of the sample (27 cities), there is no compulsory connection for stormwater (Type 1), while in a third of the sample (16 cities), compulsory connection and usage exist but are mitigated by the possibility of exemptions (Type 2). Only one

city enforced compulsory connection and usage without any exemptions (Type 3). In a previous study from 2012, telephone interviews were conducted with municipal stakeholders in Type 2 cities (n = 20) to understand the administrative procedures for granting exemptions and the justifications for and against them. The study revealed that many cities approve exemption applications if there is evidence of sufficient soil infiltration capacity. Few cities based their decisions on other factors, such as the existing sewerage system and the risk of overload during heavy rainfall events [10, 12].

When asked why they opted against strict enforcement of compulsory connection and usage (Type 1), many municipalities cited the benefits of decentralization, particularly the cost savings from not having to reconstruct sewerage systems. Some municipalities also pointed to state water law requirements as a reason for granting exemptions. However, most municipal administrations opposed the complete abolition of compulsory connection and usage to maintain control over infrastructure development and prevent inappropriate infiltration measures and financial difficulties. Overall, three out of four exemption requests for stormwater compulsory connection were granted in practice.

Stormwater Charges. The stormwater charges in the sample range from 0.29 €/m² to 1.93 €/m², showing significant variation among municipalities. The unweighted average stormwater charge in the sample was 0.85 € per m², aligning with the current German average. The study also examined whether the drinking water charge correlates systematically with the stormwater charge, potentially incentivizing rainwater reuse through cisterns. However, no correlation was found between drinking water prices and stormwater charges, suggesting that drinking water prices do not systematically influence stormwater charges.

Special Rebates for Property Owners. There are considerable differences among municipalities regarding special rebates for property owners, ranging from no reduction to a full refund of charges for using specific technologies:

- Infiltration system with overflow to public sewer,
- Cistern (outdoor watering) with overflow to public sewer,
- Cistern (indoor use) with overflow to public sewer,

- Unsealing of surfaces,
- Green roof with connection to public sewer.

When comparing municipalities, no clear preference for a specific technology was found, although green roofs and unsealing measures were rewarded more frequently than infiltration systems with overflow to public sewers. Notably, more than half of the surveyed cities promote at least four of the aforementioned technologies, while one-fifth do not apply special rebates at all.

Conclusion

This article has examined both theoretically and empirically the design of key municipal institutions for integrating property owners into sustainable stormwater management in Germany. With climate change increasingly impacting urban areas, the challenge of transforming stormwater management systems arises from two main needs: reassessing local stormwater management objectives and translating these objectives into a technical infrastructure design. Property owners can either be encouraged or hindered in implementing and operating decentralized measures, and the benefits and risks of these strategies depend on local objectives and framing conditions. This paper identifies coherent institutional designs suited to incorporating property owners into stormwater management and presents an empirical analysis of current local governmental practices.

The analysis reveals the complexity of "institutional interplay," or the mutual effects of different institutions. Ensuring the enforcement of compulsory connection and usage alone does not prevent the use of some decentralization measures. However, abolishing this institution allows for the full range of decentralized technologies, addressing important aspects of water balance such as groundwater recharge. Stormwater charges play an ambiguous but crucial role, serving as both a refinancing mechanism for public systems and an incentive toward decentralization. Charges provide an effective incentive for all decentralization measures only if they are

sufficiently high and complemented by a system of rebates [5, 9, 13].

This study found four institutional designs where the impacts of compulsory connection and stormwater charges reinforce each other, leading to consistent strategies for achieving specific objectives by involving property owners to varying degrees. An analysis of 44 large cities in Germany shows that:

- The vast majority of cities allow local stormwater management measures, with one-third requiring an application procedure.

- There are considerable differences between municipalities regarding the level of stormwater charges and the design of special rebates. A comparison with a 2012 study shows only minor changes in general.

Despite finding examples of coherent institutional designs, many municipalities still employ inefficient decentralization strategies that lack proper incentives for implementing appropriate measures. Potential explanations for these shortcomings include constrained decision-making capacity within municipalities, divergent individual interests, institutional barriers at higher federal levels, and the need for robust institutional designs under conditions of uncertainty.

This paper contributes to the ongoing debate about sustainable stormwater management by showing empirically that decentralization on private properties is becoming increasingly important. It highlights the gap between realized institutional settings and theoretical considerations regarding coherent institutional designs, encouraging municipal stakeholders to consider the interplay of institutions when revising them. Finally, the paper calls for a differentiated view of local stormwater management, as the effects of institutional designs and their interplay can only be understood against the background of specific local objectives, strategies, and framing conditions.